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The Study of Technical Change

By Carter Goodrich, *Washington, D. C.*

Ever since cotton gin and steam engine inaugurated the industrial revolution, technical improvements in mechanisms of production have continued to precipitate profound problems of social as well as industrial readjustment. Mr. Goodrich sees in the United States Coal Commission's report on Underground Management in Bituminous Mines, prepared by Sanford Thompson and his associates, a notable attempt to predict and evaluate those inevitable changes in the life and work of the miners which are about to follow the transition from hand to mechanical loading. He pleads for a more constructive effort to see these changes in all their social as well as their technical bearings, in the hope of "control before and not after the fact."

WE USUALLY study industrial revolutions only after the event and after their social consequences have tumbled unexpectedly upon us. The Coal Commission and Mr. Sanford Thompson have broken away from this bad habit. "The Report on Underground Management" takes a technical change in its beginnings and analyzes it in the public interest. The soft coal industry is apparently "just entering" upon a transition from hand to mechanical loading that will change the whole manner of life and work underground. Mr. Thompson and the engineers who assisted him have studied the new process in its first successful experiments and have used their analysis both for prediction and evaluation. The change is surely coming, they say, and the change is good.

The evaluation itself is not surprising. There is nothing new in the spectacle of technicians praising technical progress. But there *is* a new element in the grounds that are given for it. Technicians have usually judged such changes solely in terms of production and profits; the effect on the workers has been someone else's business, or nobody's. This Report uses times and costs and output figures as skilfully as any, but it also considers such questions as the placing of the men whose jobs the machine would take and the effects of the change on the safety of the miners and even on the quality of their working life. Here, then, is a second break from bad tradition.

But the trouble with the Report is that this second break is not a clean one. The authors are genuinely

interested in the miner and in his "contentment during working hours," but their joy in the machine leads them, in a complex human situation, to see and to select only those facts that favor the change. This one-sidedness is least evident in their argument on safety, but it is very obvious in their hasty assurance that there will be no serious problem of displacement, and it is well illustrated in their discussion of the effect of the change on the nature of the working life.

Here the Report admits no doubts whatever. Other industrial changes may have made men's jobs less desirable; this one will do nothing but improve them. Hand loading is "irksome and solitary." Machine loading will replace it with work "of a higher type, requiring greater initiative."

But the facts are by no means so clear. It is true that hand loading is rough hard work and that it is done by ones and twos instead of in gangs. But the Report itself, in other connections, adds quite different elements to the picture. "In addition to being a trained specialist in shoveling," the miner has a considerable "change of work between loading of consecutive cars." Moreover, the boss comes only once a day, and by the system of payment "he is relieved of the necessity of driving the men." Surely if modern jobs were to be "graded," as John A. Hobson suggests, "according to the measure of the scope of skill, judgment and self-determination" they afford, there would be many below the miner's.

Nor is the other half of the statement less questionable. Mr. Thompson sees mechanical loading as likely to call for "greater initiative" on the part of the workers. A prominent coal man, on the other hand, has just argued for the great extension of machinery in the mines as part of a program to "standardize every operation down to the minutest detail so that no responsibility of any kind will fall upon the worker." The immediate facts seem to fall somewhere between the two predictions. A machine of the type the Commission studied most carefully needs not one but three new classes of workers,—a mechanic to run it, two men or a small gang to stay in the dust of the machine to feed it and do it various services, and from two to four men to go ahead of it to drill and shoot down the coal. The first and probably the third kind of work require more skill than hand loading; the second less skill than loading and much less "initiative." And while the drilling and shooting crews retain much of the traditional independence of mine labor, the other groups come under a new and constant supervision. Moreover there are other types of machines in use and in prospect which go much farther on the road of the coal man's prediction and do away with the individual work of this third group and with most of the skill of the operator of the machine. But even on the basis of the Commission's own data, it is obvious that the simple picture of an improved working life ignores the facts of the decrease that accompanies the increase in

skill and of the clear loss in the worker's independence.

The clue to this failure in the Report lies perhaps in the phrase "inevitable and desirable." The change is first proved "inevitable" and of course "desirable" on the score of cost and output. For this the authors possess a rich technique of investigation. But suppose an industrial change is "inevitable" on grounds of cost and *undesirable* on other social grounds? The authors have no equipment for facing such an issue; perhaps for that reason, the social questions enter the argument only to add a hasty and echoing "desirable" to a conclusion already reached. To have faced them more critically would have carried the engineers beyond their craft. Yet the very raising of the questions is of value in pointing to the need of a new social technique.

For the road on which the Report set out is one of genuine promise. Always in the past, industrial changes have plunged us without warning into grave social problems. It is a new and important thing to see such a change before it is upon us. If we could also see it in its social as well as in its technical bearings, there would be real hope of control before and not after the fact.

Measurement in Vocational Selection

An Outline of Research Procedure

(Continued from the October number)

By Max Freyd, *J. Walter Thompson Company, New York*

The first installment of Dr. Freyd's outline of research procedure in vocational selection discussed the necessary preliminary steps, the choice of the criterion of vocational success or failure by reference to which the merit of the selective procedures must be evaluated, and the construction of the tests or other instruments for use in measuring vocational ability. The present paper outlines the steps to be followed in giving the tests in an experimental way, and in evaluating them. A final installment will treat of the practical use of these measurement methods in industry.

III. Obtaining and Evaluating Measurements

E. GIVING THE TESTS

ADMINISTERING tests is a matter which demands both careful standardization of conditions and tact in dealing with the subjects. The conditions will not be as rigid as those of a laboratory experiment, but tact and courtesy will be of more importance.

The experimenter may safely leave the matter of arranging the time of testing and insuring the presence of the subjects to the executive most immediately concerned with the success of the experiment. If he is testing for ability at some minor occupation, he should arrange with the foreman or executive the details of time of testing, and this executive will notify the men when to appear. The executive should not tell the men the purpose of the experiment, but should leave that to the examiner. If the executive or foreman in immediate charge of the workers is antagonistic to the tests, the examiner will have to use salesmanship, for otherwise he may cause antagonism among the men toward the tests. If the executive in charge is favorably disposed it is probably safe for him to explain briefly to his men the purpose of the experiment. If the men are on a piece work basis some arrangements for compensation will have to be made. No worker should feel under compulsion to take the tests, and if no amount of salesmanship is sufficient to convince a recalcitrant worker, he should be excused. When the others are tested he may change his mind.

If men holding responsible positions are to be tested, greater difficulties will be encountered. Executives consider their time too valuable to be spent in experimenting, and they can be more independent in their attitude toward what they regard as side-issues. These men may be reached most readily for group testing at conventions or other times of assembly if a high executive is sufficiently interested in the test results to motivate them.

1. The test conditions. Elaborate conditions may be set down to which the testing room must conform, but in most industrial and commercial organizations the examiner will have to be satisfied with what he can get. Link describes an ingenious portable laboratory which he was able to set up near where the men were employed. This arrangement has its disadvantages, but is necessary if shop operatives are being tested who for one reason or another cannot be taken far from their work. Some of the conditions which a room for individual testing should satisfy are the following:

Absolute privacy should be secured. No one other than the examiner and the subject should occupy the room at the time of testing.

Freedom from interruption should be insured. Rooms used for test purposes should not contain important material which must be referred to often. If the telephone proves annoying, the examiner may muffle it.

The room should be relatively free from noise.

The room should be well-lighted.

It should not be too far from the place of work.

It should be cleared of objects apt to distract attention.

To some extent the room should reproduce the conditions under which the man works, since unusual conditions are apt to provoke unusual responses.

Suitable writing space should be provided for both examiner and subject.

Pencils should be provided for the subject. In order to prevent him from wasting time during the test by erasing, or attempting to sharpen a broken point, the pencils should be sharpened at both ends.

The cumulative stop-watch which has a sliding lever near the stem is the most satisfactory type, as it is noiseless in operation and allows the examiner to take time out for unforeseen interruptions or difficulties. The usual type of stop watch springs back to zero after being stopped, and cannot be used for recording cumulative times. Decimal stop-watches and split-second stop-watches have peculiar advantages for certain kinds of measurement.

It is sometimes convenient to have a small screen on the table so that the examiner may keep his tests out of sight, or record scores without being observed by the subject.

A set of shelves or files for tests should be provided.

Since group testing will ordinarily not require as much of the examiner's time as individual testing, any large room may be taken over temporarily. The room should not be so large that the examiner cannot be seen or heard distinctly from any part of it. Persons who are near-sighted or hard of hearing should be assigned seats near the examiner. Writing space should be provided for each subject; the men should not be crowded; and care should be taken to prevent cheating.

2. The procedure. In individual testing, the experimenter must first set himself the task of putting the subject at ease. His introductory talk cannot very well be standardized, because it then becomes artificial and stilted; it should be flexible and be adapted to the attitude of the subject. Considerable salesmanship will be necessary with some subjects. Informality and courtesy are essential, but should not be carried to familiarity. The examiner will do well to introduce himself and call the subject by name during the interview. In his introductory talk he should give a frank and brief account of his purpose in giving the tests unless this has already been taken care of in a general notice or bulletin to all the subjects. The examiner should convey by his bearing and speech his impression that the subject will not hesitate to take the tests. The introductory talk should not be so long as to put the subject on edge and make him nervous. As soon as he takes his eyes off the examiner's and looks around for the tests it is time to start the examination.

No one should be tested who is in pain or suffering from any temporary disability. The examiner will have to differentiate between the usual advance rationalizations and valid reasons for not taking the tests at the time.

The examiner should master the directions for the various tests so that he can say them quickly and accurately. Above all, he should preserve his composure during the tests. He should do nothing to antagonize the men who are tested.

A rather easy test or a few simple questions asked in a casual manner may be used as shock-absorbers.

The stop-watch should be kept out of sight, and the subject ought not to see the scores as they are recorded.

Not more than an hour at a time should be given to testing, unless the subjects cannot be brought together again.

If a person shows the effects of hard work on the tests, the program may be interrupted at the conclusion of a test by a few minutes of conversation.

The examiner may motivate the subject by commenting favorably on his test performance, but this cannot be done generally without evoking suspicion. If the subject is doing poorly, nothing should be said. He should not be prompted.

If the subject expresses disappointment at not being able to complete the test during the time allowed, the examiner should reassure him by explaining that relative standing is the important factor.

While the subject is engaged in completing a test the examiner may put in the time to advantage by scoring the preceding test.

Workers will often request the examiner to give them their scores or to tell them their weak points. One answer to this is that the whole affair is as yet merely an experiment, and the individual's score is of no significance until standards of comparison have been secured. The ground for this answer should have been prepared in the introductory talk.

Just before the subject leaves he should be warned not to tell others about the tests, as that will give them

an advantage over him when their turn comes to be tested. They will come already prepared and will be able to score higher than he did.

In general these remarks hold good for group testing also. The examiner will have to be on the alert to prevent cheating, but should not exercise such close supervision as to cause nervousness. He should warn all against allowing their neighbors to see their papers, lest they lower their own relative standing in the tests. No talking should be permitted during a test, but there should be a brief period of relaxation between tests.

F. EVALUATING THE TESTS

It is assumed in this discussion of statistical devices that the reader is familiar with the contents of one or more of the standard text-books on statistics, such as Rugg (82), Yule (125), West (115), Brown and Thompson (13), Jones (42), Thorndike (103), Kelley (45), and Davenport (24), and that he knows the meaning and significance of these statistical concepts: normal distribution curve, class intervals, median, mode, mean, standard deviation, probable error, mean variation, critical scores, percentiles, quartiles, deciles, scatter diagram, regression line, correlation coefficient, and multiple and partial correlation coefficients. This section will do little more than enumerate the various statistical methods of evaluation; references will be made to writings on methods of computation. A slide rule and a set of tables (Pearson, Crelle, Barlow) are almost indispensable.

A procedure which follows directly the administration of the tests is the tabulation of the raw data. If a large number of tests are used or if the subjects of the experiment are numerous, it may be advisable to use Hollerith cards. Rugg (82, Ch. III) describes various ways in which data may be tabulated. Tabulation puts the data in shape for rapid and convenient statistical treatment and for ease of locating any individual record. In tabulating, the experimenter should not fail to make use of additional scores which the test may yield, since each new set of scores derived from a different aspect of a test provides the equivalent of a new test.

If the experimenter is working with applicants rather than with old employees it will be necessary to lay the data aside until reliable figures are at hand on the vocational success of the men. He should take particular pains in this case to see that no figures are given general publicity lest they influence the judgments of the men with whom the workers are associated. In any event, however, it will be found advisable to place in the hands of an executive a duplicate set of the scores to quiet any misapprehensions that may arise.

The evaluation of the tests consists of the comparison of two series of measurements made of the subjects of the experiment: the test scores and the criterion of success. The degree of concomitancy of these two variables can be determined accurately and stated mathematically. We infer the predictive value of the tests under future similar conditions from the degree of observed relationship be-

tween test scores and criterion. The test score in the practical situation is always the known variable, and from it the probable degree of vocational success may be predicted on the basis of the known relationship of test scores and degree of vocational success. It is not necessary to state why this relationship exists, although this is a matter of interesting speculation. Presumably the cause of the relationship between the two variables lies in the constitution of human beings; but before generalizing to this extent the experimenter must be reasonably certain that the observed relationship is not due to circumstances which are found only in special groups such as the group on which the tests are evaluated, and which would invalidate his conclusions as regards applicants in general. These factors may be sorted out by the process of partial correlation.

There are two phases of the statistical treatment of test scores. One is the establishment of the degree of relationship between test scores or answers to questionnaires and the criterion of vocational success. This either gives us a figure such as the coefficient of correlation or establishes on statistical grounds the degree of differentiation into classes of vocational accomplishment which is possible by the use of the tests. These indices of relationship are convenient to have and summarize the prognostic value of the tests. The second phase relates to the statistical devices for carrying the results into practical application, its aim being not so much to establish the relationship existent as to make the optimal use of this relationship. The first phase may be omitted entirely in the evaluation of the tests, as in many cases it gives a false impression of the true practical value of the figures. The two phases of test evaluation will be treated in two sections below.

Statistical procedures ought not to be used which are obviously too refined for the type of measurements to which they are applied.

1. The index of relationship. a. Correlation. The coefficient of correlation (r) is a single numerical index of degree of interrelation of two variables. It may range from $+1.00$ to -1.00. The closer it approaches unity the closer the tendency for one variable to vary as the other (directly, if the sign is positive, and inversely, if the sign is negative). The *scatter diagram* represents the score of each individual in each of the two series of measurements.

Pearson's product-moment formula is the one which has been accepted by statisticians as basic for computing the correlation coefficient:

$$r = \frac{\Sigma xy}{N\sigma_x\sigma_y}$$

There are several variations on this formula, among which are those given by Thurstone (105) and Rugg (82, p. 274). Other types of formulas for obtaining the correlation coefficient under diverse conditions are described below. A clear and detailed method of computing r may be found in Rugg. Forms for use in calculating the coefficient of correlation have been produced by Thurstone (105), Toops (109), Crathorne (22), Holzinger (39), and others. These forms present the

process in outline and have blank spaces for inserting the figures for the particular problem; they serve, therefore, as time and labor savers and as checks on the inclusion of all the necessary steps. With practice it becomes possible to estimate r quite accurately from the scatter diagram. In general, the product-moment coefficient should be used when the number of cases is about fifty or more and when the measures are in their original form and not in the form of rank order. A coefficient of 0.30 or more is usually significant, although so many factors enter into the situation that no limit can be set dogmatically. Thus, the correlation coefficient should always be interpreted together with its probable error, the formula for which is

$$\text{P.E.}_r = 0.67449 \frac{1 - r^2}{\sqrt{N}}$$

This formula is applicable to the product-moment and rank difference correlation coefficients and the correlation ratio, but not to the fourfold table method. It assumes a normal correlation surface (see Yule, p. 321, 352). P.E.$_r$ may be obtained quickly from tables given by Rugg (82) and Pearson (72) or by graphic methods given by Toops (110) and Pearson (72). Ruml (83) gives a formula from Yule which is a better method of determining the predictive value of a test than the correlation coefficient itself. This is the formula for the root mean square error of estimation:

$$\epsilon = \sqrt{1 - r^2}$$

It "expresses directly the magnitude of the error made in predicting the values of one variable from the values of another." It varies from 0 to 1, inversely as the values of r. It is the same as the "coefficient of alienation" (k) mentioned by Kelley (43).

The product-moment coefficient takes into account the absolute value and position of every measure in the series, and requires the use of the mean and the standard deviation of the series. There are several other methods of obtaining r which are used when the number of cases is small, when the divisions are alternative rather than continuous, or when the measures are in terms of ranks.

The method of rank differences takes into account only the positions of the measures in the series, and should be avoided, if possible, when there are more than 30 cases. There are two formulas: Spearman's method of rank differences

$$\rho = 1 - \frac{6\Sigma D^2}{N(N^2 - 1)}$$

and his "footrule for correlation"

$$R = 1 - \frac{6\Sigma g}{N^2 - 1}$$

Both ρ and R may be converted into r by the use of tables provided in most text-books on statistics, based on formulas derived by Pearson. The Scott Company has prepared convenient tables which shorten the process of obtaining r by the first of these two formulas (89).

The fourfold table method is still simpler but has a high probable error and is at best only a rough indication of the amount of correlation. Here again we have two formulas, Pearson's cos π method

$$r = \cos \frac{\sqrt{bc}}{\sqrt{ad} + \sqrt{bc}} \pi$$

and Sheppard's method of unlike signs

$$r = \cos \frac{U}{L+U}\pi$$

Rugg supplies convenient tables from which r may be read off when the per cent of unlike signed pairs is known. These two formulas take account only of position above or below the measure of central tendency in each series. The fourfold table corresponds to the scatter diagram divided into four compartments by the means or medians of the two distributions, if recognition is given only to the compartments into which the measures fall. The method is useful when the number of cases is less than fifty, when the answers to a test are alternative, or when the criterion of vocational accomplishment is in terms of success or failure. It is to be avoided when other methods are applicable, and of course cannot be used when the conditions are such that the series cannot be divided into two approximately equal groups owing to the fact that the measure of central tendency falls within a large class interval. For diagnostic purposes the method of critical scores is preferable. (See below, p. 278.)

There are several *graphic methods* of computing the correlation coefficient. One of these is Galton's graphic method, described by Rugg (82, p. 245), which requires the computation of the median and the quartiles, although the same may be accomplished by obtaining the means and the standard deviations (125, p. 203). Correlation is measured by the closeness with which the line connecting the quartiles or standard deviations (and necessarily passing through the median of the scatter diagram) is approximated by the line of the means or the regression line. Another graphic method is given by Yule (125, p. 203):

> The means of rows and columns are plotted on a diagram, and lines fitted to the points by eye, say by shifting about a stretched black thread until it seems to run as near as may be to all the points. If b_1, b_2 be the slopes of these two lines to the vertical and the horizontal respectively,
>
> $$r = \sqrt{b_1 b_2}$$

Other short statistical methods of estimating correlation are given by Yule (p. 204) and Brown and Thompson (p. 129).

Sturges (97) gives a formula for finding r for a whole group if r for sections of the group is known.

Pearson biserial r (13, p. 127), obtained by a rather complicated formula, may be used in the case of "two variates one of which is both quantitative and continuous, while the other, though quantitative, admits of only two subdivisions, or, in more technical language, is 'alternative.'" This method seems to have a direct application when the criterion is alternative and the test score continuous (or vice versa), although its complication will stand in the way of its frequent use in researches in vocational selection.

Ruml (84) shows an application of this formula to setting critical scores and to the establishment of the optimum criterion of success for correlation with the tests. It is not necessary for the tests to predict exactly what a man's standing in the measure of vocational accomplishment will be; it is only necessary to know whether

the tests predict accurately whether he will be good or bad. If the measure of vocational success is continuous, it remains to find where the division line shall be placed for success and failure in order to obtain the highest correlation with the tests. By calculating biserial r with the numbers in the alternative categories varying (that is, by calling the successes the upper 10, 20, or 30 per cent in the criterion of success), the division point may be found which yields the highest correlation with the test, and the criterion of success may be placed at that point. On the other hand, the alternative categories may be set with regard to test scores, the criterion being continuous, and the most favorable critical score in the test obtained by finding the dividing line which yields the highest correlation with the criterion (expressed as a continuous variable). The result will be in terms of per cents and will have to be transmuted into scores. Ruml (85, p. 59) gives the formula for the *rank-tangential coefficient* (t), which is equivalent to biserial r applied to ranked data.

The correlation ratio is a truer measure than r of the relationship of two variables if the relationship is non-rectilinear. The formula and the method of computation may be found in Rugg or Brown and Thompson, and blanks for convenience of computation are given by Crathorne (22) and Holzinger (39). The correlation ratio is greater than the correlation coefficient in the case of non-rectilinear regression, but in linear regression the two are approximately equal. The correlation ratio is always positive.

The coefficient of mean square contingency (C), while not a measure of correlation, is closely allied to it. It is used to determine the relationship between non-measured, alternative, or attributive variables. Some test responses and answers to questionnaires or measures of vocational success are susceptible to this treatment, but both series must be non-quantitative. The data are plotted very much as in the fourfold table, and C then "measures relationship in terms of the difference between the numbers of measures actually found in the various compartments of the correlation table (or 'contingency' table more generally), and the numbers that might be expected there by pure chance."

The following are some of the factors which reduce the amount of correlation:

Actual absence of relation.

Restriction in the range of either variable.

Failure to keep a third variable constant.

Inaccuracy of the original measures.

Loaded sampling.

b. Group comparisons. If the criterion of success is such that the subjects of the experiment may be divided into two or three large groups—the successes, the failures, and an average group—we may obtain an index of the value of a test or questionnaire by observing the differentiation of these groups in test scores or answers to questionnaires. Ordinarily it is necessary only to compare the successes and the failures, and if there is a third group it need only lie between the other two in test scores.

Differentiation by test scores may be studied by drawing distribution curves of test scores for each of the groups of vocational accomplishment; that is, by superimposing distribution curves in any test of the successes and the failures in the particular vocation. The differentiating capacity of the test may be observed by noting the overlapping of the two distributions. The means of the distributions of test scores for vocational successes and vocational failures should be computed. The standard deviations of these means are obtained by the formula

$$\sigma_m = \frac{\sigma_d}{\sqrt{N}}$$

The standard deviation or standard error of the difference in means is obtained by the following formula (Yule, formula 7, p. 346):

$$\epsilon_{12} = \sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}$$

The σ's here are the standard deviations of the two distributions to be compared, 1 and 2. If the difference in means is two or more times as great as the standard error of the difference, the difference is significant. A good example of the use of this method is given by Fernald, Hayes, and Dawley (29) and Dewey, Child, and Ruml (26). The significance of the difference may be expressed in a generalized statement derived from the normal surface of error, to the effect that the chances are 1 in n that the difference (in means) is not real and not in the direction indicated. If, for instance, the difference in means is four times as great as the standard error of the difference, then at 4σ on one side of the normal surface of error the difference will disappear and beyond that point it will be in the other direction; that is, the mean which was formerly greater will now be less. The probability expressed above is simply the per cent of measures in the normal probability distribution which fall beyond 4σ on one side of the curve (for this particular problem).

A different formula is used when a group is compared with a sub-group; for example, when comparing all employees tested with successes among them.

The formula for the standard deviation of the difference between the mean of a sub-group and the mean of the total of which it is a part is given by Pearson (Biom., vol. V, p. 182) as

$$\sqrt{\frac{\Sigma^2}{N} + \frac{\sigma^2}{n}\left(1 - \frac{2n}{N}\right) - \frac{n(M-m)^2}{N(N-n)}}$$

where Σ is the standard deviation of the total and N the number of cases in the total, σ the standard deviation of the sub-group and n the number of cases in the sub-group, M the mean of the total and m the mean of the sub-group. (29, p. 114.)

Differentiation by questionnaire items may be computed somewhat similarly. This method consists of the comparison of the proportions of the two groups (vocational successes and failures) giving certain answers to certain questions. If the difference in proportions is two or more times as great as the standard error of the difference in proportions, the difference may be called significant. The formula for the standard error of the difference in proportions is as follows:

$$\epsilon_{12}^2 = \frac{p_1 q_1}{n_1} + \frac{p_2 q_2}{n_2}$$

where p_1 is the proportion of one group indicating the answer, q_1 the proportion of the same group not indicating the answer, p_2 the proportion of the second group indicating the particular answer, and q_2 the proportion of the second group not indicating the answer. n_1 and n_2 are the numbers of individuals in the two groups. The method is fully explained elsewhere (32).

The formula for comparing the total with a sub-group by this method is given by Yule (p. 271):

$$\epsilon^2_{01} = \frac{p_0 q_0}{n_1 + n_2} \cdot \frac{n_2}{n_1}$$

The symbols have the same meaning as in the above formula, the subscript $_0$ referring to the total, $_1$ to the sub-group and $_2$ to the total minus the sub-group 1.

2. Statistical applications. The foregoing sections dealt with the establishment of the relationship between test scores and the criterion of vocational accomplishment. The practical value of the tests for the purpose in hand may, however, be far in excess of their value as indicated by any of the methods outlined above. There are other ways of handling the data which bring out their practical value, and which do not necessarily require that the evaluation proceed first according to the methods outlined above. It is assumed, however, that the foregoing methods have demonstrated that the tests have some significance, before embarking upon the use of the following methods.

a. Based on correlation. If the correlation coefficient is so high as to establish beyond question the relationship of test score and criterion of success, we need some means of putting this knowledge to use. The correlation coefficient, if high, merely tells us that in general test scores are related to success in the vocation, but it gives us no indication of the probable success of an individual who obtains a certain score. The general equation by which one of the related variables may be determined when the other is known, or which gives us for each value of one variable the most probable value of the other related variable, is known as the *regression equation.* The accuracy of the predicted value of the unknown variable cannot be determined from the regression equation, but is indicated by the size of the correlation coefficient. For every correlation table there are two regression lines and two regression equations, and the experimenter must always be certain that he is using the one which will predict the criterion when the test score is known. Knowledge of the correlation coefficient is not a necessary prerequisite to the use of the regression equation, although r must be known in order to determine whether or not the regression line or equation has value. The *regression line* is the graphic representation of the regression equation. It may be obtained in three ways: It may be estimated by using a string and shifting it about on the scatter diagram until the most likely position has been found; it may be obtained by the method of least squares; or it may be obtained by the regression equation, in which case the correlation coefficient and the standard deviations of the two distributions must be known. For

discussions of the regression line see Thurstone (106, p. 6) and Rugg (82, p. 248). The regression equation may take three forms. It may be expressed in the form of the original measures, as

$$Y = a + b \cdot X$$

in which Y is the most probable value of the criterion for the given test score X. It may be expressed in the form of deviations from the means of the two series of measures, as

$$y = b \cdot x$$

in which y and x are deviations from the means of their respective series. No additive constant (a) is necessary here because the point of origin is the intersection of the means of the two series. Or it may be expressed in terms of deviations from the means with the standard deviation as a unit of measurement,

$$y = r \frac{\sigma_y}{\sigma_x} x$$

In the last two equations we are given values of x in terms of deviations from the mean of the x distribution, and the predicted y is also in terms of deviations from the mean of the y distribution. Values of y or Y may be obtained from given values of x or X either by reading off the values from the regression line or by computation with the regression equation.

A second method of handling figures which have been evaluated by the method of correlation is the construction of *percentile curves* and tables, which has been very adequately explained by Thurstone (104). The percentile curve or table gives us for each test score a corresponding figure representing the per cent of individuals who obtain scores lower in value than this score. This method differs from the preceding one in that, instead of predicting success in terms of the criterion, it indicates it in terms of the per cent of applicants whom this individual will excel in the test, or in the criterion if the correlation between the two is high. Both methods depend upon the establishment of a high correlation. The percentile curve in itself without a knowledge of the correlation coefficient, means nothing. If a grosser division than hundredths is desired, tables of deciles, quintiles, or quartiles may be calculated.

b. Based on group comparisons. When group comparisons are made in test scores, practical procedure demands the determination of the most favorable score or scores for group differentiation. A test score above which or below which one group (successes or failures in the vocation) are in conspicuous excess over the other group is called a *critical score.* The best procedure in establishing critical scores is to plot scores of successes and failures on the same chart, indicating successes by one kind of symbol and failures by another kind. If there is an intermediate group of fair successes, they may be represented by a third symbol. The experimenter may then easily observe by inspection in what sections of the distribution one grade of success is represented in greater relative proportion than the other grades. Such sections may be set off by critical scores, and then become *critical sections.* No section ought to be set off which does not take into account a fairly large proportion

of the total number of persons, otherwise it will not be of much significance. Critical scores may be determined by observation or by the method previously quoted from Ruml. The statistical significance of a critical section is discussed below. How the method of critical scores may be used is shown by Yoakum (123, chart 8) and Moore (65).

Critical scores may also be set with regard to a combination of two tests. If the scatter diagram of the two tests be plotted, each individual being indicated by a symbol which shows the class of vocational accomplishment to which he belongs, sections of the scatter diagram may be set off within which one grade of success is represented in relatively greater proportion than the others. These sections may be mapped out and the critical scores stated in terms of the two tests, as for example, "it is a favorable indication if a person scores between a and b in Test X and at the same time scores between m and n in Test Y." This method should not be pursued unless there is some ground for the belief that both tests are of some differentiating value. Its use is very well shown by Bills (8).

Two methods are open for making statistical applications of differences found in *answers to questionnaire items*. Both relate to the determination of a scoring method for the questionnaire which will include the significant questions. If it has been found that a larger proportion of the vocational successes than of the vocational failures indicate a certain answer to a question, it may simply be assumed that the difference is significant and that the indication of such an answer is favorable to success. We may select in any questionnaire all the questions which are answered in a certain way by different proportions of the two groups (successes and failures), and base a scoring method for the questionnaire on them alone. For each answer which is given by a larger proportion of successes than failures, the individual receives a score of $+1$; and for each answer which is given by a larger proportion of failures than successes the individual is given a score of -1. His score for the questionnaire is then the algebraic sum of the scores assigned to the significant answers which he gives.

A refinement on this procedure is to determine the significance of the differences in proportions (the ratio of the difference in proportion to the standard error of the difference), and to include only those items which pass a criterion of significance (such as the difference being at least twice as great as the standard error of the difference). To be still more technical, each answer may be assigned a weighting according to the size of the ratio mentioned above. This procedure, however, does not bring results worthy of the added labor (32).

The total scores for questionnaires, as determined by these methods, are quite valuable for group discrimination. The significance of the total score may be determined by correlating it with the criterion of success or by making group comparisons as shown in section 1b above. It may be applied by using the regression equation, percentile curves, or critical scores.

The significance of critical sections may also be determined by treating the alternative categories assumed in setting critical scores as if they were alternative answers to questions, and examining the differences in proportions of the two groups found in the critical sections with regard to the criterion of significance mentioned in the last paragraph but one.

G. COMBINING TEST SCORES

When the evaluation of the various tests has been completed, it is of advantage to combine scores and obtain a total score for each person which shall express the maximum predictive value of the component tests. The predictive value of the tests will vary considerably, and it will cause considerable confusion if an applicant is accepted or rejected on the basis of a number of uncombined predictions. Unless test scores are combined, the final judgment will be partly a subjective one. Furthermore, since the total score should have more significance than scores in any one test, the accuracy of prediction will be greater. The experimenter must be warned against over-refinement of statistical method in obtaining a total score.

1. Based on the establishment of correlation. It is assumed that each of the tests has been correlated with the criterion of success. In the first five methods to be described, no attention is paid to differences in correlation, the assumption being that no test will receive consideration unless it has shown a significant correlation with the criterion. The sixth and seventh methods of obtaining the total score take into consideration the relative significance of the tests.

The simplest expedient is that of *adding raw scores* made in the various tests. This method is open to the error of giving some tests undue weight over others. If the range of scores in one test is from 1 to 5, and in another test from 50 to 100, simply adding raw scores would give the second test much greater weight than the first test in the total score. This may or may not be justifiable, depending on the conditions of the research. Even though the range of scores in two tests is the same, the test with the greater standard deviation will be given more weight if raw scores are added.

The meaningless weighting which is a source of error in the above method may be reduced by *weighting to equalize the medians or means* in the various tests. If the median score in one test is five times as great as the median score in another test, then scores in the second test are multiplied by five before adding. This method, of course, does not take into account the dispersion of scores in the two tests.

All tests may be given equal weight and dispersion may also be accounted for if scores in each test are *expressed in terms of the standard deviation* of the scores in that test (118). To obtain any person's score in a test in terms of the standard deviation, the deviation of his score from the mean of the distribution is divided by the standard deviation of the distribution, and a plus or minus sign affixed, depending on whether his score is above or below the mean. If the test

shows a high negative correlation with the criterion, then of course a plus sign is affixed before a score which is below the mean (and vice versa). The individual's total score is then the algebraic sum of his standings as thus computed in each of the separate tests. This procedure may be followed by substituting the probable error or average deviation of a distribution for the standard deviation.

A method which equalizes the weights assigned to the various tests but which takes only relative standing into account, is to *add percentile standings* in the various tests. The total score obtained in this manner must be considered as a measure of relative standing only. Decile or quintile standings may be added in the same manner.

The above methods aim to assign equal weight to the various tests; but this may be a poor ideal to strive for, since the tests will vary in value. Tests may be weighted roughly according to their *reliability*. This may be determined inferentially by observing their length or the stability of the scores which they yield. The reliability of a test may be calculated by giving it a second time and obtaining a second indication of the criterion (103, p. 177), but these are conditions which the experimenter will rarely be able to fulfill. The reliability of the test may be observed by noting the change in correlation with the criterion upon use with disparate groups of subjects, simultaneously or successively. The reliability coefficient, however expressed, may then be used in giving relative weight to the various tests. This method of weighting, however, has little to recommend it.

A rough system of weighting which may be employed when each test has been correlated once with the criterion of success, is to assign weights to the various test scores in accordance with the *size of the correlation of the particular test with the criterion.* Test scores must previously have been equalized by weighting to overcome the weakness pointed out in the first method in this section.

The most accurate statistical process for combining the results of several tests is to use the *multiple regression equation.* For a complete discussion of the multiple correlation coefficient and the multiple regression equation, see Kelley (43), Yule (125, chap. XII), and Rosenow (80).[1] These writers use slightly different symbols. The multiple correlation coefficient, expressed as $R_{1(23\ldots n)}$ or $r_{1(23\ldots n)}$, is the highest correlation obtainable between the criterion, 1, and a combination of the various tests, $23\ldots n$. The multiple correlation coefficient may be obtained by the formula given by Yule (formula 15, p. 248). The same formula appears in Kelley's monograph in terms of the coefficient of alienation (k) (formula 7, p. 15). The formula may be expressed as follows:

$$R^2_{1(23\ldots n)} = 1 - (1 - r^2_{12})(1 - r^2_{13\cdot 2})$$
$$(1 - r^2_{14\cdot 23})\ldots(1 - r^2_{1n\cdot 23\ldots(n-1)})$$

Each of the partial correlation coefficients may be obtained in terms of lower order correlation coefficients by the formula given by Yule (formula 12, p. 238). When the necessary zero order correlation coefficients (the

[1] See also: C. L. Huffaker, A contribution to the technique of partial correlation, Jour. App. Psych., 1923, vii, 135–142.

simple correlation of two variables) are known, R may be obtained very quickly, by a process of building up, step by step. All zero order relationships should be linear. The sign of R must be inferred from the data. R is never less than the correlation of the criterion with any of the constituent tests, and is usually greater than the highest correlation between the criterion and any one of the tests. In order to apply the results we make use of the multiple regression equation, for the multiple correlation coefficient would not tell us how much to weight each test. The proper weighting is obtained by solving the multiple regression equation, and the multiplying constant for each test is the partial regression coefficient of the criterion on that test, each of the remaining tests being held constant. The equation for the scores in their original form is as follows:

$$\overline{X}_1 = b_{12\cdot 34\ldots n}X_2 + b_{13\cdot 24\ldots n} X_3 + \ldots b_{1n\cdot 23\ldots n-1}X_n + c$$

"in which the b's and the c are constants, so chosen that when the variables $X_2, X_3, \ldots X_n$ are multiplied by the successive b's and added to c a final measure, $\overline{X}_1$, is obtained which is the most accurate estimate of X_1 possible of attainment" (43, p. 14). The formula for obtaining the additive constant is given by Kelley on the same page. Formulas for obtaining the multiplying constants are to be found in Yule (p. 236–237). If the measures are to be expressed in terms of their deviations from the means of their distributions, the formula is the same as the above, except that small x's are used and the additive constant, c, is omitted. Thurstone (107) gives a simplified method of obtaining the multiple correlation coefficient for three variables. His method may be used for combining scores in two tests, if for R (right) and W (wrong) are substituted symbols for the two tests which are to be combined in order to obtain the highest correlation with the criterion. The results obtained by his method will be in terms of deviations from the means of the distributions. Chapman (16) describes a procedure which may be followed for "the investigation of the effect of adding a single test to a battery already weighted as though complete in itself."

2. Based on group comparisons or critical scores. The following methods are applicable to the combination of test scores in tests which have been evaluated by group comparisons and in which critical sections have been set off. If the tests have not been correlated with the criterion—which is assumed in this section, since otherwise the preceding methods of combining scores could be used—it will be absurd to attempt to add scores made in the critical sections. The critical section has been set off because of the discrimination within the section as a whole, and differences in scores within the section are not to be recognized. And in addition, the method would open to the objection that, owing to the different ranges of scores in the various tests, there would be an unwarranted weighting of scores in some of the tests. Some means must be devised for giving a unit value to all scores falling within a certain critical section.

If the critical scores for the various tests have been set so rigidly that all have equally high significance, there is no point in weighting scores. In that event, the individual is allowed ±1 for each critical section (in all tests) in which his scores fall. Taking any single test as an example, and assuming that a critical section has been found in which there are many more successes than failures, if any applicant scores in that section he is given + 1 for that performance. Again, if a critical section has been found in another test (or in the same test, for that matter) in which the failures are represented in greater proportion than the successes, then any applicant who scores within that section is given −1 for that performance. An individual's total score is the algebraic sum of the points which he earns for scoring within critical sections in the various tests. If he does not score within a critical section in a test, he receives zero for that test.

If critical scores have been set less rigorously than in the above instance, the points assigned to the various critical sections need not be uniform. If the per cents of the different groups who score in the critical section have been determined (per cent of all successes and per cent of all failures) and if the difference in per cents has been divided by the error of the difference, then the points assigned to the sections may be in proportion to this quotient. (See above under *differentiation by questionnaire items* and also reference 32. Statistically, scoring within a critical section is considered the same as indicating a certain answer to a questionnaire item.)

If critical scores have been set by the methods described previously, with due regard to differentiation within the critical sections, then the weightings assigned to the different critical sections may be in accordance with the probability of an individual's achieving success if he scores within the critical section. Thus if 90 per cent of the individuals in the critical section are successes, the probability of success of any person who scores within that section is $\frac{90}{100}$. Similarly, if 20 per cent of the individuals in a critical section are successes, the probability of success of any individual who scores within that section is $\frac{20}{100}$. The weightings assigned to the critical sections may be in accordance with this ratio or per cent. (Note that the critical scores have not been set on this basis, but on the basis of differences in per cents of each total group (successes and failures) found within the critical section. If 20 per cent of the individuals in a critical section were successes, and at the same time 20 per cent of all individuals tested were successes, no significance would attach to the critical section. But if 20 per cent of the successes and 70 per cent of the failures scored within the critical section, it would be very significant.)

Finally, the weights assigned to the critical sections may be in accordance with the reliability of the test or critical section; that is, in accordance with the length of the test, its continued significance with recurring groups of individuals, or according to the number of cases in the critical section. The latter is a very practical index of the reliability of the critical section. A critical section which included

altogether only a very small fraction of the total number of cases is more open to error than a critical section which included 50 per cent of the cases.

The total scores for a questionnaire (for which a scoring method has been devised according to methods previously outlined) may be treated as a test score, and is then open to any of the methods of combining with other measuring instruments outlined in sections 1 and 2 above.

3. The profile method. This is not, strictly speaking, a method of obtaining a total score, but presents the scores in the tests graphically in relation to each other. For each person a curve is plotted showing his relative standing in the various tests. The examiner can thus at a glance observe the good and the poor test performances of an individual. Knowing the relative diagnostic value of the various tests the examiner may make a prediction of the worker's probable success. This method is open to individual judgment in prediction, and also leads to groundless assumptions as to the traits measured by the tests and judgments on the individual's weak points. A total score is of much better diagnostic value, easier to obtain, and less subject to individual judgment. If the examiner merely wishes to know the number of tests in which the person obtains a high score, he will find that this is better expressed numerically. The advantage of the profile method is its graphic presentation, but a method of graphic presentation of a total score may easily be devised.

The total score which is finally established may be evaluated the same as any individual test by any of the methods mentioned in section F, and any of the statistical applications may be used. The total score should, of course, have more predictive value than any individual test.

This completes our outline of procedures useful in determining the reliability and the validity of the tests and in securing from them their maximum predictive value. It remains to consider, in a final chapter, the precautions to be followed in introducing into actual routine employment practice these methods of measuring vocational ability.

To be concluded

Industrial Aspects of Human Fatigue

By Frederick Bonner Flinn, *Research Physiologist, United States Public Health Service, Washington, D. C.*

This review of the present status of industrial fatigue studies is based on investigations conducted during the past few years by Dr. Flinn for the Public Health Service in a number of industrial establishments and in the laboratories of the College of Physicians and Surgeons, of Columbia University. In preparing the review use has been made also of recent literature, especially the reports of interesting investigations being conducted in England.

FATIGUE is now generally acknowledged by the members of the medical profession as an important factor to be studied in connection with the prevention of disease. Fatigue always has been of prime importance to the worker and to the employer of labor. Nevertheless, the subject is not given, even today, the consideration necessary to get the best returns from the human mechanism. If one were to consider merely the matter of increased dividends, there ought to be a clearer knowledge of the human frame, both as to its limitations and its possibilities. Mr. A. Pugh, Secretary of the Iron and Steel Trades Confederation, truly said in his remarks supporting a resolution before the National Institute of Industrial Psychology in England:

> It seems to me that psychology and physiology enter, saying to us in effect, "You have applied yourselves to the investigation of your raw material, as to their quality and uses; and to the perfection of the inanimate machinery, to the last cog and the final bolt; but you have failed, and you will continue to fail, so long as you neglect the human factor and refuse to realize that it presents a problem far more complex than you can conceive, but one which will be certain to bring reward to patient investigation."

THE NATURE OF FATIGUE

One of the difficulties in approaching the subject of fatigue is that the word is used in two different senses and care is not always exercised to distinguish which one is meant. Fatigue should be classified as either objective or subjective. The only reliable measure of fatigue on the objective side is output. A diminishing output is an indication of the onset of fatigue. This is easily shown in testing one's strength. If a second test is made immediately after the first test, it will show less strength or work than the first test, whether we are conscious of any fatigue or not. But if we rest for a short time, we find that the second

test will equal the first. So a man working at his bench may not be conscious at the end of the day of any fatigue, even though it is evident from a diminution of his working power.

Subjective fatigue may be divided into (1) a local feeling of tiredness in an active muscle; (2) a general feeling of tiredness; (3) sleepiness. A man is not always as tired as he feels, as is plainly demonstrated by his ability to undertake further and perhaps heavier labor under the stress of excitement or powerful incentives. Still, the feeling of tiredness is a warning that he has been drawing on his storehouse of energy; that continuance of the muscular work may react against his whole organism; and that the renewed activity may result in an excessive fatigue, both objective and subjective, out of all proportion to the effort put forth.

Physiologically, fatigue may be said to be an inhibition of the higher neuromuscular centers to prevent further expenditure of energy from an already depleted supply. Fatigue originates more commonly in the central nervous system than in the muscles, and is, therefore, not an index of the exhaustion of muscular energy. Before a muscle reaches a state of exhaustion in its metabolism, the synapses and myoneuro junctions of the nervous system intervene by refusing to carry further impulses to the muscle. This action is analogous to that of an electric fuse, except that the cause is a deficiency of energy. Mosso, in reporting his ergographic experiments, stated that nervous fatigue is the preponderating phenomenon, and muscular fatigue is also, in the final analysis, an exhaustion of the nervous system.

OLD AND NEW PHYSIOLOGICAL THEORIES OF FATIGUE

In the earlier investigations of fatigue much emphasis was laid on the accumulation of waste products, such as lactic acid in the isolated muscle. The ability of the muscle to perform work when bathed in solutions containing such waste products as lactic acid, phosphates, phenols, indoles, skatoles, etc., all of which are formed in the body, was studied in an attempt to identify some specific fatigue product. All of these products have adverse influence on the ability of the isolated muscle to perform work. However, the weight of evidence seems to be against any appreciable increase in the blood stream of the amount of lactic acid—the chief product of the isolated muscle—when the organism is acting as a unit, except for momentary increases under very severe muscular exercise; and this temporary increase may be viewed as a result of a lag in the response of the respiratory and circulatory systems to the sudden strain put on them. As the circulation becomes adequate again the supply of oxygen is sufficient to reconvert the excess lactic acid to its precursory condition as fast as it is formed, and successive contractions of the muscle can follow each other for a long period with undiminished force. When the state of equilibrium is reached where the constructive process during the period of rest between contractions just balances the destructive process, the muscle is said to have reached its

fatigue level. This condition corresponds to the second wind of the athlete. If through some impairment to the respiratory and circulatory systems a sufficient supply of oxygen does not reach the muscular tissues, a stage is quickly attained at which the muscle is no longer capable of contraction. This is due to the accumulation of hydrogen ions. Each body tissue has an optimal condition of hydrogen ion concentration at which its activities are best carried on.

Many investigators have looked carefully for a specific fatigue toxin that would appear in the blood stream during the period of muscular activity and which, if accumulation took place, would cause illness and even death. Weichert was the chief exponent of this theory and claimed to have isolated a fatigue toxin which he called kenotoxin. If this product, or toxin, were injected into the unfatigued animal, it would show all of the symptoms of the fatigued animal, such as a reduction of body temperature, slowing of the respiration, sleepiness, and ultimately death. It was his contention that by subjecting an animal to small doses of this poison he could develop in the animal an immunity against fatigue for a period of time, on the same principle that people are now innoculated against typhoid fever. So sure was he of his ground that he applied for a patent in the United States. Some of his followers were so enthusiastic as to claim that the mere spraying of this anti-fatigue toxin in a school room rendered the scholars more alert and actually in as good condition at the end of the day as they were in the morning. More recent investigators have discredited his claims by showing that the same symptoms of fatigue can be obtained by injecting the muscle juice of an unfatigued animal into another animal as were obtained by injecting the muscle juice of the fatigued animal.

Of late years a feeling is arising that the changes that take place in the body during muscular exercise are of a physico-chemical nature and are not due to the formation of any particular fatigue product.

EFFECT OF VIOLENT MUSCULAR ACTIVITY

As we gain better knowledge of the human machine, we realize that any change that takes place in one section of the body may have its influence on some distant organ or gland. Any voluntary muscular activity constitutes but a small part of the total processes that take place in the body in consequence of that activity. Thus, since muscular work must depend for its energy on the oxidation of the food-stuff, any increase in activity results in an increase in metabolism which in turn demands a larger supply of oxygen. The only way that oxygen can be supplied is through the lungs by means of an increased rate of respiration. This rate during activity may be eight or ten times the requirement of the body when at rest. The burden of supplying this increased demand rests on the respiratory and circulatory systems. Increased heart rate, high blood pressure, and rapid pulse are just as much a part of the picture during exercise as is muscular contraction.

Some idea of the strain put on the heart during exercise may be gained from the fact that during rest the heart pumps about 4 liters of blood a minute, while during violent exercise its capacity may increase to 24 or 26 liters for the same period. This is made possible only by a greater dilation of the heart during the diastolic, or filling, period, resulting in a greater venous flow to the right heart, followed by a stronger contraction of the heart muscle during systole as the blood is forced out into the arteries. This big increase in load handled with unfailing efficiency is rarely duplicated by any man-made machine. All of this increased activity results in the generation of heat, as is true in all mechanical processes. This heat must be dissipated through convection, radiation and evaporation in order that the body may retain its optimum temperature of about 98.6°F. To accomplish this the vaso-constrictor nerves must be replaced in their action by the vaso-dilators, and the water shifting mechanism of the body must be brought into play. In order that all of these different processes may act as a unit and to the best advantage of the organism they must be under control of the higher nerve centers.

We have dwelt on these processes so that our minds may be refreshed as to what some of our simplest exertions really mean and so that we can realize how any industrial complication—such as dust, poor illumination, or nervous tension—by interfering with any one part of the organism may have its effect on the fatigue of the whole human machine.

FATIGUE AND ADAPTATION

Repeating a certain operation numerous times or training for athletic meets apparently permits work to be done more economically through a more complete coördination of movement. Zunst found that his dog carried on the operation of walking on the level more economically than when climbing; but when he trained the animal to ascend an incline, he found after two years' training that the mechanical efficiency for climbing was greater than for walking. Getting into one's stride no doubt means that one has adjusted the speed of his work to the natural rhythm of his body, this rhythm being set by his nervous system. Having adjusted the speed of his work to this natural rhythm he can perform his work in the most efficient manner.

If management attempts to speed up the rate of work beyond this point, efficiency begins to drop and industrial fatigue develops. Hence the manager, in hiring and assigning his men, should select the type most suited for the particular work in hand. Peters in his Handbook on Copper Metallurgy recognized this when in his chapter on matte breaking he advises the management of a plant to hire the thin nervous man for this work rather than the big phlegmatic type, because the work requires the particular kind of a blow that the first man gives and the production is larger. This is what Rowntree (1) means by the expression "mental-motor ratio."

Fatigue is a natural phenomenon. It consists simply of a period of tearing

down of the tissues during activity which is followed by a period of building during the succeeding period of rest. It is only when the period of activity is too intense or the period of rest too short to permit the rebuilding process to come into equilibrium with the destructive process that pathological conditions arise.

THE MEASUREMENT OF INDUSTRIAL FATIGUE

Naturally the question is put, if fatigue is such an important factor in the industrial field, is there no ready test by which the stage of fatigue can be determined, or by which one line of work can be compared with another as to its fatigue effects? Many physical tests and measurements have been suggested, especially during the world war, both in this country and in Europe. Some of these tests have demonstrated their value in detecting physical deterioration; but their contradictory findings, when used for the purpose of measuring physical fatigue after a day's work, indicate that they are of little value for research in the factory and are useful only to determine a man's fitness for the job at the time he applies for employment.

There remains, however, one measure of fatigue which is most reliable—though it is not infallible—the measure which was mentioned at the beginning of this article, namely, output. It should be the ideal of every factory management to arrange optimum conditions for work and then to determine what is an average maximum output that can be expected without overfatiguing the men. Any serious deterioration from this average should then be carefully studied to find out what complicating factor has come in to interfere with the mental-motor ratio. These studies will point the way to the necessary remedies, to eliminate excessive fatigue and to bring output again up to normal.

CONTINGENT CAUSES OF FATIGUE

One sees some workers coming out of the factory with heads thrown back and a look of satisfaction on their faces, while others drag one foot after another and look as if life were not worth while. Why this should be is a question too complicated for an off-hand answer. There are many individual differences among people, both in constitution and in habits. Moreover, the type of work or conditions in the shop may sometimes be blamed for the apparent fatigue when the real answer lies in the home life. For example, the management of a plant near New York employing a large number of girls had noted that their production was not what they estimated it should be. The plant physician, who knew the failing of the weaker sex for dancing late at night and getting up in the morning just in time to rush off to work with but a hurried breakfast, if any at all, obtained a sum of money from the board of directors sufficient to furnish a selected number of girls their breakfast after their arrival at work. The experiment was tried for the period of one month. The results confirmed the physician's diagnosis, for the improvement in the production of this selected group was enough not only to return the investment, but also to pay a dividend on it.

The same thing has been observed in school children. The child who on account of home conditions came to school in the morning without its breakfast, showed signs of fatigue and marked decrease in mental powers around eleven o'clock in the morning. This fatigue was apparently prevented or reduced by furnishing the child with a glass of milk at a suitable time. It may be that the custom of the old European laborer of eating a sandwich and drinking a glass of beer in the middle of the morning had good physiological foundation. Probably many business men would find a marked improvement in their work if they would rise a little earlier in the morning and take their time in eating a simple breakfast, instead of rushing through it an catching the last car of their regular train. There is no doubt but that the wealth of our country can be increased if workers and business men alike can be educated to the proper value of food, sleep and relaxation.

But industry must, after all, bear the major share of burden in the causation of fatigue; and many an employer of labor would find it to his advantage to study carefully the conditions of work and how it might be lightened, instead of leaving this question to the foreman whose prime thought is usually to get results no matter at what cost to the human machine, in order that he may make a good impression on the management. Such simple things as temperature, ventilation, illumination and congenial supervision have marked effect on a man and his ability to withstand fatigue.

FATIGUE AND ROOM TEMPERATURE

The optimum temperature for the workroom depends on the type of work being done. On broad physiological principles, one can say that the room should be at that temperature at which the heat regulating mechanism of the body can dissipate in the most efficient manner the increased heat generated. When referring to the environmental temperature, it is customary in physiology to use the wet bulb reading, since this more nearly represents the cooling factor of comfort in the surrounding atmosphere. The temperature must not be too high or it will put a strain on the heat regulating mechanism of the body. If it is low, demands are placed on the chemical regulation of the body to furnish body heat unless the activity of the work is sufficient to furnish heat through the oxidation processes of muscular work.

VENTILATION

The question of ventilation is so closely allied to this question of body temperature that it must always be considered when environmental temperature is under discussion. It has been shown by the "Report of the New York Commission on Ventilation" (2), that the carbon-dioxide content of the air is of less importance than air movement. Ellsworth Huntington has made the same point in his volume, "Climate and Civilization." He has demonstrated that continual changes over a narrow range of even one degree have a marked influence on the output of a factory. That too much atten-

tion has been given in the past to the carbon-dioxide content has been shown by the Ventilation Commission, for they have indicated that the construction of modern buildings does not permit the carbon-dioxide content of the atmosphere to rise much over 0.50 per cent. Experiments have shown that a man can live in an atmosphere containing one per cent of carbon-dioxide gas without feeling any discomfort. As the atmosphere in the open contains from 0.03 to 0.04 per cent of this gas, we are provided with a large margin of safety. Still, a high percentage of carbon-dioxide is an index of improper ventilation.

Moving air is of prime importance to bodily comfort as Hill has shown by his work with the Kata thermometer. It promotes the cooling of the body through radiation, conduction and evaporation. By removing the layer of stagnant air that immediately surrounds the body, it stimulates the nerve endings and gives one the feeling of comfort. The rate of air movement, however, should not be such as to put a strain on the heat regulating system of the body by too great a cooling through evaporation of the invisible perspiration. It is the invisible evaporation that cools the body and not the profuse sweat that rolls off a man performing heavy labor in high temperature. From our present knowledge of ventilation and body temperature, it would seem more than likely that the victims of the Black Hole of Calcutta died from heat exhaustion rather than from the accumulation of carbon-dioxide, as was at one time taught in our high school physiology.

Few executives realize how difficult it is to get good ventilation in the factory and to prevent stagnated air areas. It is customary to judge conditions by the mere reading of the thermometer. What is really required is a careful survey of the room by means of the Kata thermometer. It is a mistake to imagine that mere opening of windows will alone produce proper ventilation. Quoting from the Report already mentioned:

> The characteristics of window ventilation without exhaust ducts may be looked upon as inadequate aeration, (45 per cent of carbon-dioxide observations of over ten parts) marked odor (21 per cent of the time) and low temperature conditions which aroused dissatisfaction among the occupants. Twenty per cent of the recorded temperatures were below 65° and only 58 per cent of the observers' votes pronounced the temperature conditions satisfactory.

The disposal of fumes, gases and dust that are inherent to an industry always complicates the problem of ventilation. It is almost impossible to determine the effect of these factors from a casual physical examination of a man because their actions are cumulative. Deterioration is so slow that it may not be apparent for years and then only after a careful statistical study of the mortality of that particular industry. It has been hard to get these statistical data on any particular industry because in the past few records have been kept and what have been kept are either inaccurate or incomplete.

There seems to be no question but that careful study of the optimum temperature and air movement in each factory will do much to diminish industrial fatigue in the plant.

ILLUMINATION

A soldier on the march having a blister on his foot will have a higher metabolic rate and show more fatigue at the end of the day than the soldier whose feet are in good condition. What then must be the fatigue effect on a man who is compelled to work in a shop where the illumination is either inadequate or of improper character for his line of work? Dr. Ives, of the United States Public Health Service, has shown that even under optimum conditions as regards outdoor light there are wide ranges of differences through which the eye must accommodate itself. General recognition of the necessity for proper eye-glasses in the curing of many minor ailments such as headaches and nervousness, should indicate also the important effects of this factor of proper lighting on daily fatigue. The best light is none too good.

That illumination is of utmost importance in increasing production in unsuspected industries has been strikingly demonstrated in a British coal mine. The investigation was made under the auspices of the National Institute of Industrial Psychology (3). The men were supplied with two lamps instead of one. The glasses were treated with hydrofluoric acid so as to diffuse the light and eliminate glare. This diminished by 28 per cent the physical intensity of light transmitted, but the two lamps increased somewhat the total illumination. The miners were unanimous in their agreement as to the improvement. They felt greater comfort in their eyes. The verbatim report says "It's better for the eyes." "I like the new glasses to be also in the places on each side; my eyes are not bothered then." "It's a treat; it doesn't make me blink" (nystagmus subject). "Since I've used this new glass my eyes have not bothered me when I've got up the pit after work." A result of value to both miners and operators is that the production of the mine actually increased 4.41 per cent. This is an apt illustration of what is meant by the proper type of illumination for a particular industry. Its bearing on the reduction of industrial fatigue is obvious.

REST PAUSES AND CHANGE OF WORK

If one will plot the curve of the output of a factory hour by hour throughout the day, it will be noticed that there is a gradual rise in the production until about eleven o'clock in the morning, but from that time on there will be a pronounced fall. The same thing happens in the afternoon, after the noon recess. In the afternoon the decline in production begins about three o'clock, and is followed by a partial recovery around four, followed again by a definite falling off. This condition indicates the necessity for a rest during both periods. Experiments have shown that if a rest period is introduced at eleven and at three o'clock, there is an absence of this fall, and in the morning even a slight rise may take place. This rest period does not necessarily mean a period of idleness, for Miles and Skilbeck (4) have shown that the same result may be obtained by a change of work. They initiated a short period of organized

change of work when the fatigue period was beginning and found that it resulted in an increase in production of 14.2 per cent. In this case the change period was occupied in bringing to the benches the material that was needed for the work. Previously it had been brought to the benches at intervals scattered over the day.

In European countries there has been a marked movement toward the application of psychology in the study of fatigue. One cannot deny that many factors predisposing man toward fatigue are purely mental. The worker must be contented with his work. Bad management caused by the fact that the foreman is more familiar with machines than with the human factor is an important item in increasing fatigue. No man can be expected to give his best, who has held over his head the continual "threat of the sack" or whose work is constantly criticized for the mere purpose of keeping him working at the peak of effort.

Monotony is one of the deadly elements in the industrial field and if properly understood might account for many of our industrial accidents, even some that have been laid to gross carelessness. The sameness of the work may raise the threshold of stimulation. Rowntree says: "Monotony, to my mind, is not the characteristic of any particular task, but is a reaction which particular tasks may produce in particular workers" (1).

Rowntree lays emphasis on the mental-motor ratio, which he explains as the ratio between innate intellectual capacity and control of motor or muscular mechanism. He feels that when a man complains about the monotony of the work or when he becomes irritable, nervous and unsettled, it is often because the job is not such as maintains the right ratio between the mental and motor side of the man. A man's job should be one, if possible, that will give full play to both his mental and his muscular capacities without bringing exhaustion to either.

Enough has been said to make it clear that industrial fatigue is very complex in its causes. To deal with it effectively, there is need for research by physiologists and physicians, by industrial psychologists and engineers. To make these researches yield the greatest value to workers and employers alike, the united action of labor leaders and managers of industry must buttress and help the investigations of the scientists.

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News Notes

REPORTS OF THE UNITED STATES COAL COMMISSION

The December-January number of the JOURNAL OF PERSONNEL RESEARCH will be devoted to a summary of the studies of the United States Coal Commission. The Report exists in the form of twenty-three mimeographed bulletins, each of them the equivalent of a small volume in length, packed solid with statistical data and pertinent facts. Its mere magnitude discourages most readers from giving more than a cursory glance to this monumental product of research. For this reason it has been thought useful for the JOURNAL to undertake to bring together within the covers of a single issue, representative excerpts which will enable the reader to gather some impression of the investigation in its entirety. At the same time we are not hesitating to stress more particularly those phases of the several studies which have the most obvious bearing on the personnel aspects of the whole coal problem.

This official investigation of one of the great basic industries, unprecedented in speed and magnitude, was made with one primary end in view: to find out the facts, and having found them to make recommendations. It has been estimated that the total cost of the investigation amounted to a million and a half dollars. The greater part of this expense was contributed by the interested parties in the industry through their willing coöperation and through their minor studies made apart from the main research, in order that the parties themselves and the public might be satisfied that no stone was left unturned.

The condition of the coal mining industry today affects not only the prosperity of all American industry, but as well the comfort and well-being of the whole people. The only necessaries of life which rank coal are food and water. Every man, woman, and child depends on coal directly or indirectly for power, light and heat. Anthracite coal is the chief domestic fuel for that part of the country that has the greatest density of population, and bituminous coal, in addition to supplying comfort and warmth to two-thirds of the homes in our land, is the key-product supporting the arch of our industrial and transportation structure.

To dig this coal, eight hundred thousand men are laboring in the mines. Of this number five hundred thousand are members of unions and three hundred thousand are employed in non-unionized areas. The wages these men earn is of primary importance both to the workers and to the public who ultimately foot the bills; but the subject of remuneration is inextricably interwoven with problems of working conditions, safety, and continuity of employment; with problems of engineering and management; and with problems of marketing, transportation and storage, no less than with the puzzling problem of how to insure an equitable return to the owner on his investment and at the same time a dependable reasonably priced supply of fuel to the consumer. No commission face to face with such a tremendously complex situation could be expected to find a solution pleasing to everyone. The present Report has, however, brought forward a vast quantity of authentic data never before available. Congress and the voters, as well as miners and operators, can now face the coal question with more promise of taking steps leading straight toward an ultimate just solution.

The titles of the following reports on the bituminous industry which were published and released during September indicate in a general way the scope of the investigation: Civil Liberties, Effect of Irregular Operation and Over-development, Safety in Bitumi-

nous Mining, Waste of Coal, Earnings, Wage Rates, Labor Turnover, Engineering and Management, Wholesale and Retail Coal Trade, Storage and Fuel Economy, Investment and Profits, Purchase of Coal on Contracts, and Cost of Production. Several of the reports on the bituminous industry have not been released at the present writing; namely, Description of the Mining Population, Costs of Living, and Living Conditions.

The following reports on the anthracite industry are available: the preliminary report of January 15 and the report of July 5, together with reports on Earnings of Miners, Labor Relations, Cost of Production, Revision of Wage Structure, and Investment and Profits.

The Commission includes John Hays Hammond, *Chairman*, Thomas R. Marshall, Clark Howell, George Otis Smith, Edward T. Devine, Charles P. Neill, and Edward E. Hunt, *Secretary*.

All of the reports are addressed to the President and the Congress of the United States. They contain complete statistical tables and graphs. The investigation of Safety in Bituminous Coal Mining was supervised by E. A. Holbrook, Dean of the School of Mines, Pennsylvania State College, and Consulting Engineer of the Bureau of Mines. Dean Holbrook enlisted the assistance of a committee of specialists for the study whose names give weight to the report submitted. The examination of Wage Rates in the Bituminous Industry was made by W. E. Fisher of the Wharton School of Commerce and Finance, University of Pennsylvania, and is one of the several studies made under the general supervision of Dr. Joseph H. Willits. This report was coördinated with the latter's investigation of the Causes of Strikes, as well as with the study of Earnings, which was directed by Miss Anna Bezanson of the University of Pennsylvania. The investigation of Labor Turnover in the Bituminous Industry was made by Delos Walker and was made possible through the use of data collected primarily for the purpose of the study of Earnings. The study of Labor Relations in the Anthracite Industry was made by Messrs. Henry S. Dennison, Willard E. Hotchkiss, and Joseph H. Willits.

AMERICAN FEDERATION OF LABOR ENCOURAGES RESEARCH

The following communication which shows the admirable attitude taken by labor representatives toward the furtherance of personnel research has been received from Mr. Samuel Gompers.

"Washington, D. C.,
November 13, 1923.

Mr. Alfred D. Flinn, Secretary,
Personnel Research Federation.

Enclosed herein you will find copy of the report which the Executive Council made to the annual convention of the American Federation of Labor held at Portland, Oregon, October 1–13, 1923, under the title 'Personnel Research Federation.' You will also find enclosed the action of the convention thereon. I am sure you will be gratified with the action taken.

Matthew Woll, Frank Morrison, John Voll, Hugh Frayne, William H. Johnston have been requested to continue to act as the representatives of the A. F. of L. in the work of the Personnel Research Federation.

I should be glad to have you advise me from time to time of any matters of special interest, any meetings of committees, etc., upon which the representatives of the A. F. of L. should be in attendance.

Very truly yours,
SAMUEL GOMPERS, *President*
American Federation of Labor."

From Proceedings 43rd Annual Convention American Federation of Labor, Held at Portland, Oregon, October 1–13, 1923.

Personnel Research Federation

The significant undertaking of the Personnel Research Federation has been that of exploring the general field of personnel research. In so far as opportunities and resources have been available, the Personnel Research Federation has been seeking to discover and become acquainted with individuals and organizations that are trained and competent in the execution of research progress.

Through its periodical publication, THE JOURNAL OF PERSONNEL RESEARCH, some fifty articles in personnel and allied subjects

have been given up to the present time. It is hoped that this particular function may serve not only as a source of information to the constituent and associate members of this organization, but also as a medium through which the results of the work done may be published as an incentive to others to interest themselves in similar undertakings.

The Personnel Research Federation has found need for an additional outlet for monographs and studies and has consequently arranged for a series of books, the first of the series having appeared to date and additional volumes being under way, ranging all the way from studies of the labor problems in the printing industry to such material as that for use in vocational guidance. Unquestionably this organization has served as an effective and helpful clearing house and has on some occasions been of great assistance.

Pursuant to the action of our Cincinnati convention, the American Federation of Labor has continued its participation in the work of this organization, and with the approval of the Executive Council the following were appointed representatives of the American Federation of Labor to the Personnel Research Federation: Matthew Woll, Frank Morrison, John Voll, Hugh Frayne, and William H. Johnston. One general conference of the Personnel Research Federation was held during the past year. The officers elected for the ensuing year are as follows: Robert M. Yerkes, Chairman; Samuel Gompers, Vice-Chairman; Robert R. Bruere, Treasurer; Alfred D. Flinn, Secretary, and Leonard Outhwaite, Director. The Executive Committee elected is as follows: W. V. Bingham, Alfred D. Flinn, Emma P. Hirth, Frank Morrison, and R. M. Yerkes. Matthew Woll was re-appointed as Associate Editor.

The total voting membership is ten. The coöperating membership is forty-two, and the sustaining membership is two.

Because of the growing importance of research work and the great possibilities of the Personnel Research Federation it is recommended that the American Federation of Labor remain in active affiliation.

As is indicated by the Executive Council, in its report under caption of "Personnel Research Federation," pages 124–125, the importance of exploring the general field of personnel research should not be overlooked or by any manner or means be neglected or disregarded. Your committee is of the firm conviction that the affiliation of the American Federation of Labor with this foundation is instructive and constructive; that because of our affiliation, its investigations, reports, policies and tendencies cannot only be guided in helpful channels, but so as to avoid harmful consequences. It is, therefore, recommended that the report of the Executive Council on this subject be concurred in and our affiliation with this foundation be continued.

The report of the committee was adopted by unanimous vote.

AMERICAN MANAGEMENT ASSOCIATION

Many phases of the managerial problem were discussed at the annual convention of the American Management Association, October 29, 30, and 31, in New York. Seventeen special committees, appointed the year previous, reported their investigations on as many different topics. Many of these reports were discussed at length. All will be published as rapidly as possible and issued from the executive offices of the Association at 20 Vesey Street, New York City.

In addition to the reports of special committees, thirty-six papers and addresses were given on topics related to the subjects of management. Nearly a thousand different executives, personnel officers, and plant managers were in attendance. The convention was characterized by a seriousness and sobriety of statement that comported with the importance of the problems discussed.

Research plans for 1924 were considered at all of the sessions. The Association has not yet published these, but every session expressed the pressing need for more careful investigation of the numerous problems of management. A program of the investigations to be made in 1924 is promised for publication in the near future.

Aims of American Management Association

The Board of Directors of the American Management Association have issued the following new statement of principles and beliefs regarding the place of personnel work in management.

"The American Management Association is a nation-wide organization, established 'To advance the understanding of the principles, policies and methods of creating and maintaining satisfactory human relations in commerce and industry.'

"It stands for the principle that personnel work is an integral and inseparable part of management interwoven into all of the efforts and activities of the production and sales departments and of the office.

"It points out that the line executives are concerned directly and must deal at first-hand with the problem of human organization, including among other things leadership, and that, while they can increase the effectiveness of their personnel administration by employing a personnel man in an advisory capacity or by establishing a personnel department, yet they cannot divest themselves of their responsibility in this connection simply by so doing.

"The directors believe that the advisory personnel executive must have a basic knowledge of management in general, in addition to a complete knowledge of the technique of personnel work in particular, and that his recommendations will be of value in the degree to which they complement and dovetail with other phases of the science of management.

"It is organized on the principle that the human problem in commerce and industry is a major problem and that personnel administration is a responsibility of the line executives assisted wherever possible by the advice of staff executives trained and experienced in this field of activity. In short, without in the least denying the validity of other points of attack, it approaches the study of the whole management problem in terms of human organization.

"It studies problems of human organization—whether in the shop, in the office, or in the sales department—whether in the field of manufacturing, of banking, of insurance, of retail trade, of transportation or elsewhere."

RESEARCH ON PLACEMENT OF WOMEN WORKERS

Miss Florence Jackson, of the Women's Educational and Industrial Union of Boston, reports that by arrangement with Dr. H. S. Langfeld and Dr. Daniel Starch of Harvard University, a research is in progress on the usefulness of systematized interviews, psychological examinations and inventories of personality as aids in proper placement. A preliminary report on the study of fifty-four persons will be given in a paper entitled "The Restless Worker" by Dr. H. S. Langfeld at the Christmas meeting of the American Psychological Association, Madison, Wisconsin.

THE IMMIGRATION PROBLEM

News items recently received indicate the widespread interest being shown in the immigration problem. Careful studies have been made, and are being made, of the results of the enforcement of the Per Centum Limit Act of May, 1921, and these studies will, of course, have some bearing on the legislative action to be taken by the Congress which convenes in December, 1923. The fact that the Per Centum Limit Act of 1921 will expire on June 30, 1924 necessitates extension or modification of this Act, or the substitution of a new law by Congress.

The National Industrial Conference Board reports that Magnus W. Alexander, its managing director, in his address before the Academy of Political Science on November twentieth said, in part:

"There is a reason for laws, but there is no reason why laws should be applied in an inhuman way. We have been trying to muddle through the immigration problem, but it has not gotten us anywhere. We have a good deal of information in regard to immigration but we have much more misinformation. And at the most vital points there are great gaps in our knowledge.

"The United States cannot, for the present, close its doors to immigration, since its very existence is dependent on the operation and steady development of its various industries, and the crux of industrial operation is an adequate labor supply. Can the required supply be drawn from the resident population alone?

"The needs of normally functioning industry for immigrant workers, above the available native labor supply, have not been ascertained. Looking broadly at the problem, we must bear in mind that we shall in time approach the saturation point in the need for, and the assimilability of immigration. The statement would seem warranted, therefore, that the United States for her justifiable protection must progressively restrict immigration as this saturation point is approached, and the available supply of the country's resources per capita of population diminishes. The time will come when, as a matter of self-preservation, the United States must be reserved for the benefit of her own residents—America for Americans—and may even have to direct a surplus population into other countries."

Mr. Alexander has just completed a survey in Europe of the immigration situation from the viewpoint of Europeans, and while he admits that the present law has not created a serious handicap for industry, he suggests the following program:

"Extension of the present per centum limit act expiring next June for a few years, with certain administrative changes to remove obvious injustices and facilitate its operation.

"Appointment of an investigatory committee by the President under a resolution of Congress to report within a year on certain phases of the act.

"Determination of the nation's immigration needs through broader and better knowledge of the primary and collateral factors in the immigration problem so that any later structural changes in the law may be predicated on a knowledge of the facts and on justifiable assumption."

In concluding his address Mr. Alexander stated that, "Industrial leadership would subscribe to such a programme, for industrial leaders realize fully that an employer is also, and first of all, a citizen and therefore anxious to protect and develop the country's social life and institutions no less than to strengthen its economic fabric."

Study of migration and labor supply

The News-Bulletin of the National Bureau of Economic Research reports that Dr. Harry Jerome, under the supervision of Dr. Wesley C. Mitchell, has started work on an investigation of Migration and Labor Supply. The Bureau is making the study at the request of the National Research Council. Dr. Mitchell, in outlining the Bureau's purpose in undertaking this study, says, in part:

"Since the National Bureau of Economic Research aims 'to aid all thoughtful men, however divergent their views of public policy, to base their discussions on objective knowledge as distinguished from subjective opinion,' it is keenly interested in the series of investigations into Human Migration, inaugurated by the National Research Council.

"There are few public questions on which men now differ more sharply than on the wisdom of maintaining, relaxing, or abolishing the present restrictions upon immigration into the United States.

"The Research Council, representing the scientific interests of the country, holds that the national policy should be shaped in the light of the best obtainable knowledge of the causes and effects of mass movements of population from one country to another.

"To gain such knowledge it is necessary to enlist the coöperation of workers from several fields—biology, anthropology, sanitary science, psychology, economics and sociology. Accordingly, a committee of the Council has been appointed to select qualified investigators and to secure such coördination of their work as is necessary. But each group of investigators will define its special problems, choose its own methods of work, and publish its results.

"Upon the foundation laid in the Bureau's work and the Government's records, Dr. Jerome is building an important superstructure. He believes it will be pos-

sible to throw light upon the way in which the varying supply of foreign labor has affected the growth of various industries, and how it has modified their industrial technique and organization.

"There is a widespread belief that the remarkable development of labor-savng machinery during the last few years has resulted largely from the relative scarcity of cheap labor. Recent critics have pointed out that the connection between the price of labor and the extent to which machinery is used is far from simple. May it not be, however, that changes in the differences between the wages of the labor that makes machines and the labor that uses machines are of great economic significance?

"In addition to making use of the available published material, Dr. Jerome hopes to secure the coöperation of industrial leaders and experts in the solution of this problem.

"To study the effect of labor supply upon industry is, however, only one phase of the problem. It is just as important to discover the causes as well as the effects of immigration. An effort will be made to measure as accurately as possible the importance of the relative forces which cause foreigners to move from their old homes to our shores, or as is true in many years, to return to their foreign places of residence.

"Needless to say, the field of inquiry is so large that it is impossible to cover it quickly with any degree of completeness, but it is believed that certain fundamental phases of the problem can be successfully analyzed within a short time and that this analysis will give us a much clearer insight than we have formerly possessed into one of the most important problems confronting the American people. If so, the work will be of service to every citizen, and especially to the voters who must share in determining the immigration policy of the United States."

PUBLIC PERSONNEL STUDIES

The Bureau of Public Personnel Administration in Washington has issued the first of a series of pamphlets which are to appear under the title of "Public Personnel Studies." Although these studies may appear at somewhat irregular intervals, it is probable that there will be at least one number each month.

The following paragraphs quoted from the preface to the first number indicate the purpose and content of the studies:

"The results of the work of the Bureau will be made available as promptly as possible through publication in this form. No particular order of presenting subjects will be followed, but as the Bureau completes a given project or part of a project the results, if believed to be of fairly general interest to civil service administrators and to others concerned in public personnel administration, will be published in pamphlet form.

"At times the general policy of the Bureau of making the results of its work available as promptly as possible may lead to some repetition; that is, a pamphlet may be published on the completion of part of a project, and some of the material may have to be repeated when the entire project is completed. At times, too, the numbers may anticipate somewhat the results that are to appear later in a more elaborate publication or report. It may happen that this plan will give rise to a situation in which further work on a project may necessitate a modification or a restatement of the conclusions presented in an earlier number. The general purposes of the Bureau will be at all times consistently to give the best information available at the time any particular publication is issued, even though that information may not be entirely consistent with what has been published previously.

"As to the nature of the contents, the general policy of the Bureau will be to publish only such conclusions as are supported by good current practice or other facts or by sound opinion. The members of the Bureau's staff have been selected because of their qualifications for the work, and in addition manuscripts, prior to publication, are submitted to the Advisory Board for approval. Within reasonable limits the members of the staff will be at liberty to express in their manuscripts and reports their own opinions and conclusions based on their whole experience and knowledge even when the soundness of such opin-

ions and conclusions cannot be demonstrated by detailed proof. The Bureau as an organization will not necessarily endorse all the opinions expressed by the staff members; in some cases opinions will be published as opinions to be used by readers as such and subject to verification through subsequent investigation and experience. It may be that the making available of opinions based on studies by the staff members will be one of the greatest contributions the Bureau can offer to those interested in public personnel administration."

The first issue of "Public Personnel Studies" discusses some of the fundamental principles in the development and application of intelligence tests. A later issue will present a comparative study of intelligence tests and will describe in detail the methods of giving the tests and the procedure in scoring and interpreting them. The comparative study, in turn, will be followed by an issue devoted to intelligence test questions with a detailed description of the method of designing intelligence tests. A number of experiments are contemplated which will determine the value of intelligence tests as against other types of tests in the selection of employees for given occupations.

"A Comparative Study of Clerical Tests" is the title of the second number of the series. This particular number treats comprehensively of tests of ability in arithmetic and spelling. Dr. L. L. Thurstone is the author.

For detailed information concerning the formation, aims, and contemplated work of the Bureau of Public Personnel Administration, reference may be made to the News Notes section of the following issues of the JOURNAL OF PERSONNEL RESEARCH,—July, 1922, Volume 1, Number 3; October-November, 1922, Volume 1, Numbers 6 and 7; March, 1923, Volume 1, Number 11.

Book Reviews

STUDIES IN THE THEORY OF HUMAN SOCIETY

By Franklin H. Giddings. New York: Macmillan Company. 1922. Pp. 308

REVIEWED BY GLEN U. CLEETON

The purpose of this book as stated by the author is that of serving as a "book of Sociology without the form or formality of a text." He feels that the cardinal ideas and principles set forth are "important in these days of loose thinking on social themes."

The reader will find that the sequence of material presented and the interrelationship of topics is not always obvious. The author appears to be happy in this fact as he finds therein an opportunity to present material that might otherwise have been readily omitted. To many, perhaps, this breadth of content along with the author's style of addressing himself directly to his readers will add to the interest in the book.

Characteristic of the work of Dr. Giddings the present volume is based upon the "historical method" of sociological analysis. Since he is committed to such a procedure we find that a portion of the book is well devoted to a presentation of a "Theory of History" (Chap. V). In summary form (p. 92) the following position is taken in regard to history: "History then is adventure and the urge to adventure is the cause of history. This proposition is the kernel of my theory." In spite of the emphasis placed upon this assumption the reviewer was unable to determine from a careful reading of the theory as to how it would necessarily revolutionize sociology.

The book overemphasizes the selective influence of environment upon its population. Although recognized, the presentation minimizes the selective influence of the population upon its environment and its membership. The reviewer feels that this error is inherent in the historical method of analysis.

Dr. Giddings finds himself committed to a mechanistic stimulus-response psychology. Upon this he builds what he assumes to be a new discovery in social psychology, notably a system of "pluralistic behavior." To quote: "Pluralistic behavior is the subject-matter of the psychology of society, otherwise called sociology, a science statistical in method, which attempts, first, to factorize pluralistic behavior, and second, to explain its genesis, integration, differentiation, and functioning by accounting for them in terms of variables (1) stimulation and (2) the resemblance (more or less) to one another of reacting mechanisms." At this point the writer also takes care to call attention to the fact that he has long ago pointed out that "The psychology of society and social psychology are different things." To Dr. Giddings its seems that psychology of society and sociology are identical.

The reading of the book failed to impress the reviewer with the distinction which is attempted between "the psychology of society and social psychology." Perhaps unfairly but certainly frankly the reviewer is obliged to state that the volume appears to be an attempt to write a theoretical system of social psychology. In spite of the author's assertion that pluralistic behavior belongs to a science statistical in method he makes only a feeble attempt to introduce statistical material in this book. I feel sure that no statistician or experimentalist would be deeply impressed by the statistical treatment of the topics of "Socializa-

tion" and "Individuation" which conclude the discussion of "Pluralistic Behavior."

Due to style the book is, at times, pleasant reading. It also has merit in that it is thought provoking. To those who have an aversion to reading psychology as written by psychologists, the book presents an opportunity to read (in part) psychology in its theoretical stage as written by a sociologist.

COMMON SENSE IN BUSINESS

By Harold Whitehead. New York: Thomas Y. Crowell Company. 1923

REVIEWED BY JOHN MCCLAIN

Using the author's words, "the purpose of this book is to offer to the business man some of the fundamentals of business in its largest aspects." Various subjects discussed no doubt will be of value to the executive as well as to the employee, for it is hardly possible to read the book without feeling that it can be used as a guide to the reader in his business life. The author conveys the impression that he is telling you in ordinary conversation of some of the vital aspects of the business in general. The style is very pleasing, not technical, and yet to the point. Where a conventional term or allusion would emphasize his point, he does not hesitate to use it.

Generally speaking, the plan of the book seems to be very much like Roger W. Babson's "Making Good in Business." It contains much advice for the young man who is about to enter into a business life and much consolation for the executive who has practised some of the suggestions which the author has idealized.

In all, the book contains twenty-six chapters devoted to what the author considers prominent factors in any successful business or business life. He begins by saying that "the future of American business and American civilization are both obviously contained in the moral and spiritual fiber of each one of us. The bigger and better we become the greater America will become. The more truly great America becomes, the better, happier and more prosperous will the rest of the world become. Today's big job, then, is to *build men*." He then proceeds to tell us that one of the most fundamental factors any successful business organization could practise is infusion—that of constantly looking for and developing young men in the organization. He tells us that it is better to retain, train and encourage a present employee, than to experiment with unknown material, and to make haste slowly in filling a vacancy. Further, it is pointed out that it would be folly to select a man fifty years old for an executive position no matter what his past record has been, for his value to an organization would probably terminate within the next ten years.

The book contains chapters on "Tact," "Coöperation," and "Rules," that bring out many points in which ordinary common sense can accomplish the most good. The author believes that probably these three points constitute the more important phases in executive administration. In a later chapter "Friend Wife—Job Builder," he demonstrates by the use of practical illustration that domestic tranquillity is essential in successful business.

There is a very interesting chapter entitled "Fundamentals vs. Incidentals" which demonstrates one of our most common faults—that of making much over little. "We are successful in business when we make our actions conform to fundamental facts, and base our decisions with these facts in mind. Every decision we make from the moment we leap from bed in the morning to the time we retire for the night should be made with the fundamental facts in mind. All day long we are rendering decisions. We have to decide what we shall wear to work, where we shall have lunch, what credit we shall allow a new customer, what kind of socks to buy, etc. All these decisions must be made from facts—fundamental facts. Wise is he who cultivates the habit of making decisions based on con-

sideration of fundamentals." In a later chapter the author endeavors to establish a right mental set for the business man in which he shows the consequences of fear and the benefits of determination and untiring effort. The next, ethical in its nature, deals with "right" versus "expediency."

There is quite a generous section of the book devoted to salesmanship, which is Professor Whitehead's favorite subject. As a result of his textbook "The Principles and Practices of Salesmanship," the author has boiled down the fundamentals of successful salesmanship. He dwells at length on the service end of selling. There is included quite a bit of material on the different types of salesmanship. The book is concluded with a chapter entitled "Condensed Common Sense" which might well be placed on a high pinnacle for continual observance by the successful business man.

No doubt, this book was written as a result of Professor Whitehead's rich experience derived from business contacts in Boston. Many of the stories and examples included in this volume are too real to have been fancied. On the other hand, some of his suggestions seem too ideal to be practical. In all it is a very pleasant book to read and no doubt will prove interesting to anyone who comes in contact with business in any form.

BLACKSTONE STENOGRAPHIC PROFICIENCY TESTS

Yonkers, New York: World Book Company. 1923

"This first test of a series designed to measure all elements of stenographic ability can be used independently for measuring progress, classifying students, and diagnosing difficulties. It may also be used for employment purposes.

"Extended investigations have shown that strokes, defined as 'all single movements in typing' are the most nearly equivalent units to be found, and the stroke was therefore chosen as the unit of measurement. The material used in the tests conforms to the requirements of the ordinary business letter vocabulary, as the business letter probably constitutes the greatest part of the stenographer's work. Three minutes was selected as the time requirement after tests of varied length had been given to a large number of pupils. It was found that the results of a three minute test are as regular as those of any longer period, and a three minute test is easier to administer. Also, the average letter typed by a stenographer does not require more than three minutes.

"Five alternative forms of the test in typewriting are provided in order to test proficiency at frequent intervals without repetition of material. These five forms—A, B, C, D, and E, are equal in difficulty. The number of words, letters most frequent such as e, t, and a, letters to be struck with the right hand or left hand, carriage returns, shift key strokes, and difficult words are approximately the same in each form.

"Complete directions for giving and scoring the test and tabulating the results are included in the manual. Provision is made for keeping a record of the progress of each individual in speed, accuracy, and combined score, and also for keeping record of the progress of the class as a whole. A percentile graph facilitates comparison of scores and shows the results graphically. Norms showing expected scores of an individual who has had various amounts of instruction are given."

Abstracts

Grading the Office Job. FORREST A. KINGSBURY. Administration, March, April, May, and June, 1923, Vol. 5, Nos. 3, 4, 5, and 6, and Management and Administration, July, 1923, Vol. 6, No. 1.

Describes the procedure used in and the results obtained from an investigation of over 300 jobs in the Continental and Commercial National Bank of Chicago and about 150 jobs in the First National Bank of Detroit. Considers, also, the adaptability of the same procedure in other lines of business.

The task was twofold; it called for job analysis and job grading. "Job analysis implies the accumulation and analysis of an accurate body of detailed information about each job, the nature of its duties, the conditions of work prevailing, and the requisite personal qualifications demanded. Job grading, on the other hand, means the measurement of the importance of each analyzed job by means of a scale which indicates just how much weight should be assigned to each of the significant factors in that job description. The devising of such a scale constitutes, of course, the most difficult problem."

In the Chicago investigation two sources of information were used, *viz.*, the departmental manager and the chief clerk or any other executive who has knowledge of the details of departmental operation. In the Detroit investigation these sources were supplemented by employees' written statements of their detailed duties and conditions of work.

It is good policy to use employees' statements with a view to both amplification of information and for giving employees a voice in the investigation. In all cases the appeal used to secure coöperation on the part of employees and managers was met with a cordial response.

Significant facts about each job were obtained through the use of a six page mimeographed job analysis questionnaire. "Although long, because demanding repetitions in different forms of the same information, that very feature was deliberately fostered. The results demonstrated the wisdom of the plan. When the same facts are approached from different angles, the individual who supplies the information must have it very accurately and definitely in hand or he will be quite certain to make inconsistent statements. These, under a rigid cross checking, will reveal themselves; the necessity of correcting them will bring the inquiry back to the original sources, and the actual facts can then be ascertained by personal investigation."

Although descriptive answers were required in parts of the questionnaire, most of the questions were designed to require only a simple yes, no, check mark, or figure. This made it possible to obtain definite and unambiguous statements.

Several types of frequently recurring errors were found, and these were detected and corrected first by a preliminary review of the data by the executives in charge of the investigation; second, by a critical review and attached corrections on the part of the writer, followed by reviews of the executives and the chief clerk. These reviews required much time and painstaking effort, but were productive of good results in the end.

A list of possible differentiating factors was prepared from the questionnaires first completed, and each of these factors was examined critically be a variety of statistical methods for the determination of its reliability as an indicator of various job grades. The following eleven factors were included in the final form of job-grading scale:

	points
1. Degree of complexity of duties	1 to 3
2. Degree of executive responsibility involved	0 to 6
3. Degree of responsibility for money or negotiable instruments	0 to 4
4. Personal contacts with public involved	0 or 1
5. Sex required	0 or 1
6. Minimum age at which workers will ordinarily be accepted	1 to 10
7. Minimum general education necessary	1 to 5
8. Minimum special training necessary	0 or more
9. Previous experience demanded	0 to 7
10. Personal qualities considered essential	0 to 8
11. Minimum degree of general intelligence necessary	2 to 5

Each of these eleven factors was given a weight range according to the minimum or standard prevailing requirements. For any job the sum of weights given to the factors as they influence that job constitutes the *grade index*, which is the numerical indicator of the job's relative importance.

The process of weighting the factors was approached by the preparation of a series of detailed definitions for each factor. "During the progress of both investigations the weights and definitions were constantly tested by whatever standards were available, and where necessary they were changed, so that the final weights and definitions represent judgments which have been found valid for all of the jobs graded, nearly 500 in number. Among the checks used were lists of jobs within each department ranked in order of estimated importance by the department manager and also ranked independently by the chief clerk—the executive who had, in each bank, a more intimate knowledge of the details of the work of all departments and employees than any other individual. Again, each questionnaire showed the actual and possible lines of promotion to and from that job, affording another basis for testing the validity of the scale by comparing grade indexes of different jobs in each promotion sequence.

"This procedure gave, within each department, and to a certain extent in related departments between which transfers and promotions are common, several criteria of the relative importance of the various jobs. When these were not in exact accord, the details of the job and of the promotion sequence were scrutinized, as well as the structure of the scale, and corrections made to bring them into harmony. Then, as an additional check, various comparative lists of similar or related jobs in different departments were prepared and inter-departmental comparisons made, until it seemed that further attempts at correction would be unprofitable, and that the scale was demonstrated to be valid for every type of banking job. In final verification, the gradings of similar jobs in the two banks were checked against one another, and after making allowance for differences in practice in the two places, the independent gradings of such positions were found to correspond so closely as to prove that the worth of the scale was not limited to a single institution."

"An indispensable part of any successful job analysis program is adequate provision for making the data available for practical use. Therefore, the more extensive and intensive the investigation, and the larger the mass of data thus gathered, the more imperative becomes the obligation to work out adequate methods of systematic analysis, summary, and report. In each of the two bank investigations which this account describes the most important objects sought were the preparation of job specifications for the use of the employment office and the grading of the jobs for purposes of salary readjustment."

The information obtained in the job analysis was made available for these purposes through the use of the three following types of record forms:

"1. The summary grading sheet, on which the details of the grading were first entered.

2. The job specification sheet on which these and other data were summarized in convenient form for actual use.

3. The salary chart, by means of which a comparison could be made of the grade-index of each job with salaries actually paid for that work."

The data available from the questionnaires after the preliminary review and correction was summarized in tabular form on the summary grading sheets. Each sheet contained about twenty jobs. Subsequent corrections on original data were transferred to the summary grading sheets. "After the final grading had been accomplished, the details were transferred to the permanent job specification sheets, one sheet to a job." The form has been reproduced in the article. When the final editing of certain information that has been transferred from the questionnaires to the job specification sheets has been accomplished the former may be filed away and ordinarily need not again be used.

The salary grade index chart is constructed with column headings of key number of job, grade-index of job, and number in job group. The rows are labelled grade-index and salary paid. When the data are plotted on such a chart and a line is drawn across the chart so that it follows each change in the grade-index, it will gradually climb as it crosses the sheet, and will reveal at a glance the extent of, and the specific location of, points of non-conformity between salary and job-grade. In using this type of chart for salary readjustments the *man* as well as the *job* must be studied, for there are many causes which may operate to produce the apparent inconsistencies.

In the last article of the series there is described the procedure of adapting the methods already described to other lines of business. This description concerns itself mainly with three items: the deciding of what factors to include in the scale, the weighting of each of these, and the measurement of their validity.

"Job factors, to warrant inclusion in even a tentative job-grading scale, must meet these requirements:

1. They must be relevant to *all* jobs, not merely to a few.

2. They must be clearly *discoverable* and *definable*, not dependent on unverifiable opinion, either of employee, manager, or investigator.

3. They must be *quantitatively* describable."

After the selection of job factors has been accomplished there remains to be discovered those factors which consistently differentiate the higher-grade from the lower-grade jobs, and the determination of the range of weights to be assigned to each and the formulation of definitions for each degree of weight.

Methods of checking validity, making improvements in the scale, and the adaptability of the job-grading scale are discussed.

A Study of Clerical Work Improves Methods. I. Horace Van Nice. Management and Administration, September, 1923, Vol. 6, No. 3, p. 332.

Describes the method used by a planning division to overcome office confusion.

It was noticed that certain portions of the planning division were congested and there was a great deal of interference encountered in moving from place to place. Observers were placed at points where the motions of employees would be carefully watched while carrying on their work.

"The first discovery was that the movement was not caused by restlessness or the desire to visit, but apparently by the fact that each group of clerks had an information unit to which each individual had constantly to go in following up the daily routine. A motion study within groups was instituted with the following interesting discoveries:

"Seventy-five per cent of the clerks' time, on the average, was spent in gathering and transferring information. Twenty per cent of the day was actually spent in reading and copying the information, fifteen per cent was spent in waiting in turn with the various other messengers who were busy at the files, and forty per cent of the day was wasted in moving around between desks and information files. In other words, the clerks were working under a terrible handicap which reduced efficiency and therefore made it

necessary to hire more help than the job actually warranted."

It was discovered further that each clerk was interested in only a small portion of the information file. The confusion was easily corrected by changing to a system of duplicate files, the portion in which each clerk is interested being placed in his desk, and kept live by copies from the master file.

"Not only have the aisles become cleared of traffic, but each clerk is now able to do much more work than formerly. Therefore the size of the planning division has not been increased to correspond with the increase in other parts of the organization."

Intellectual Workers and the Labour Market. VINCENZO CASTRILLI. International Labour Review, September, 1923, Vol. 8, No. 3, pp. 361–366.

Since the war the difficulty of finding work for certain classes of intellectual workers has become so universal that it suggests the probability of a supply much greater than the demand.

In spite of the increasing cost and time of training, more and more students every year are applying for admission in the universities of almost every country. A comparison of the number of students of Italian universities in law, science, arts, and medicine in the sessions 1913–1914 and 1921–1922 shows an increase of about 70 per cent. The increase for the same period in Germany is about 70 per cent and in Great Britain 100 per cent. Twenty years ago there were enrolled in the universities of the United States about 100,000 students; in 1910 there were nearly 200,000; in 1918 about 300,000 and now there are about 400,000.

"In the face of the numerous difficulties in the way of finding employment for intellectual workers either at home or abroad, it seems indispensable that private effort should be supplemented by government and other official action. The form which outside help should take has been indicated more than once by experts. The state ought to take the foremost place, as the representative and guardian of the interests of society, as well as on account of its duty of promoting higher education for professional careers. But an essential preliminary to the success of action of this kind is the possession of accurate knowledge of national and international needs as regards intellectual workers. Knowledge based on newspapers, consular reports, and similar sources, which are usually incomplete and often founded merely on personal impressions, is insufficient. The only adequate method of studying a collective phenomenon of this kind is a systematic inquiry on statistical lines."

It is suggested that a study be made in every country similar to that made by Lexis in Germany, in which he determined the number of graduates which should be supplied in a normal year to meet the needs of the several professions. After such studies have been made a balance might be obtained by migration.

"The final task of the enquiry would be to give as accurately as possible a numerical estimate of the resultant total excess or defect of intellectual workers, so as to provide governments and others interested with a solid foundation on which to base their policy. It might, for instance, appear desirable to restrict entry to certain branches of study in order to eliminate the unsuitable at an early stage instead of later on, with the double result of lessening the disappointment in store for the youth whose capacities are not on a level with his ambitions and of raising the standard of work of the remainder.

"It might also be possible for governments to agree on some plan of exchange of certain categories of intellectual workers to meet the special needs of their respective countries. The increasing tendency to specialization in science would enhance the value of this form of intellectual collaboration, not only from the point of view of the individual in search of work but also in the interests of scientific progress.

"When the Committee on Intellectual Cooperation of the League of Nations decided to set up an enquiry on the conditions of intellectual work in the various countries it showed that it was aware that study and knowledge of the facts must precede any attempt at action. One of the soundest elements of such study would be such an

international statistical survey as is here suggested."

How Germany Settles Industrial Disputes. EMIL FRANKEL. Monthly Labor Review, September, 1923, Vol. 17, No. 3, pp. 8–18.

Since the collapse of monarchial government in Germany in November, 1918, there has been a remarkable spread of trade unionism and of collective bargaining. The growth of collective bargaining has influenced the adjustment of disputes so that nearly all collective agreements in force in Germany make provisions for the voluntary settlement of disputes. This desirable development of self-government in industry has caused the State to legalize collectivism in labor administration by recognizing employers' and workers' organizations as legal representatives of the respective groups. Collective agreements of predominate importance have been declared binding upon all employers and workers who are not parties to the agreement.

The governmental legal agencies established for the settling of industrial disputes are supplementary to the voluntary conciliation agencies established through collective bargaining. The chief task of the governmental agencies is to prepare the ground for collective bargaining and to urge parties in dispute to establish collective agreements. The proposals of the conciliation boards are not enforceable by law but are awards urging the parties in dispute to embody the proposals in a collective agreement. Only in case conciliation fails completely can the State declare any award legally binding.

Two distinct kinds of legal conciliation agencies have developed in settling industrial disputes. For settling individual disputes special courts, in which an equal number of employers' and workers' delegates act as an advisory council, have been established. The need for conciliation agencies in dealing with collective disputes prompted the government to intrust the special courts with the duty of acting as special boards of conciliation in so-called collective disputes. The jurisdiction of these courts as conciliation boards was limited to certain kinds of industrial workers whose earnings did not exceed a given amount, to low-salaried commercial and technical employees.

Since the revolutionary government (1918) recognized the value of the existing special conciliation boards, an order was issued which provided for an extensive reorganization of the existing machinery and established the following rules of procedure:

1. Conciliation boards shall intervene only in collective disputes which arise in connection with existing collective employment contracts.

2. The boards, one for a given district, shall consist of six members—two permanent and one temporary representative from both employers and workers.

3. The jurisdiction of the individual conciliation board shall be limited to the district in which the dispute occurs. In important cases when a large number of workers or special industry is involved, the Federal Ministry of Labor shall undertake the work of conciliation.

4. If a party fails to appear after having been requested to do so, or if the party declines to negotiate, or refuses to recognize the jurisdiction of the board, the board shall be bound to make an award. Awards need not be accepted except in disputes over the issuance of shop rules in which case awards shall have full legal force.

Definite statistical information concerning the effectiveness of the conciliatory system is not yet available. However, experience has shown that conciliation boards have been of great influence in extending collective agreements and the development of labor legislation is likewise due to the activities of these boards.

Ways and Means of Maintaining Safety Interest. National Safety News, September, 1923, Vol. 8, No. 3, p. 30.

Reports that perhaps the hardest problem of the safety engineer, in a plant where accident prevention work has been carried on for a number of years, is to keep alive the interest and continually to develop new ideas for this purpose.

Various methods of arousing and maintaining safety interest are discussed at

length in several of the Safe Practices pamphlets of the National Safety Council. For ready reference by safety men who are looking for something new, a detailed list is presented which contains the following general headings with sub-heads under each: Bulletin Boards; Plant Magazine; Distribution of Letters, Printed Matter etc.; Meetings; Committees; Suggestions Systems; Prizes and other Rewards; Schools; Special Contests; and Campaigns.

What About the Living Wage? ROBERT J. ANDERSEN. Industrial Management, September, 1923, Vol. 66, No. 3, pp. 140–144.

The living wage is a daily argument presented for higher wages. The reason given for paying a living wage is "because the cost of living is increasing." Unless wages are increased when the cost of living is increased, people must lower their standard of living. However, the standard of living is not something that can be chosen by one person or by a wage board for another person. A standard of living is a personal affair and there are millions of standards of living. Wherever authorities do agree with this unreliable standard, they limit it to the establishing of an absolute minimum wage beyond which a man cannot live. This is not the principle of the cost of living on which organized labor leaders base the "living wage."

Labor leaders argue that American industry can afford to pay a living wage. A comparison of the standards of living in European countries with those in this country shows that we have a higher standard. It is because of this higher standard that we have to pass laws to restrict immigration.

Again they argue that "opponents of the living wage greatly overestimate the money cost of the living wage." An understanding of a few economic principles answers this argument. "All commodities are valued in their relation to other commodities as expressed in the money value placed on them by the inexorable law of supply and demand. Wages are a large part of the total cost of all commodities either directly or indirectly. This cost is measured in terms of money. We only have just so much money, so many productive hours, so much of farm commodities, etc. Therefore, what is given to one must be taken from another. It is only as the productivity, wages, purchasing power position of all classes as a whole are in proper balance that all can have prosperity."

Furthermore, they make the charge that all of our charitable institutions and agencies exist largely because a considerable part of the population receives insufficient incomes. If one leaves out those cases due to heredity, environment, physical weakness, etc., he finds that most of the crime and pauperism is generally due to three factors:

1. Trying to get something for nothing.
2. Refusing to accept and believe in fundamental law.
3. Fostering the feeling that an individual can do something when no one is looking and get away with it.

Again it is desirable to have a living wage, for every family should have at least three children if the race is to perpetuate itself. "Nevertheless though some of us were reared in houses where the income was insufficient to meet any theoretical budget, the fact remains that we were neither underfed nor undernourished, nor underschooled, for we were taught that in order to accumulate a surplus we must not only balance our budget but have a little over."

There is a need for a standard of work which will indicate what we should give for that which we receive in return. "Until the time comes when the living wage based upon the cost of living is founded on some standard of work, we are willing to take our chances with public opinion and the economic law of demand and supply."

Critique of the Association Test as Applied to Advertising. DONALD A. LAIRD. Journal of Experimental Psychology, October, 1923, Vol. 6, No. 5, pp. 357–365.

In 1919 the author gave a list of 25 words, names of commodities, to a group of students in psychology with instructions to write down the brand name associated with each commodity listed. As a by-product of

this experiment twenty-three observers were asked to write down the brand of talcum powder that they purchased if they were consistent in purchasing the same brand from time to time.

This preliminary experiment was followed up by another in the fall of 1922, when the subjects were given 15 stimulus words and told to respond with the first brand name they could think of. Three days later they were given the same list of stimulus words with instructions to respond with the name of the brand they consistently used. If they did not use any brand consistently, they made no response to that stimulus word. Four months after this experiment 28 members of the original class were given the list of fifteen words to which they were to respond with the first brand that they thought of. A comparison of these results with those of the earlier experiment gives insight into the inconsistency from time to time in thinking brands.

The conclusions drawn by the author are:

(1) That while association tests may be invaluable to the structuralist in ascertaining how the mind is composed, they do not carry over with equal value to a practical situation such as is presented in advertising.

(2) That there is many a slip between the thought and the purchase, which is really of genuine importance in the commercial field, and which is glossed over and ignored in an association-test psychology of advertising.

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